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ABSTRACT

This book is the synthesis of a research project that explored innovative management practices in the domain of university-industry linkages. Managers from 12 higher education institutions in Europe, Africa, Asia, and Latin America were invited to document their experiences in the management of interfaces, financial and personnel management, and the management of intellectual property. The case studies demonstrate that while relations with enterprises are increasing, institutions tend to adopt more proactive and better coordinated management approaches. They are also devising necessary rules and procedures to protect the traditional activities of higher education institutions from outside interference in order to make the most of university-industry linkages. The chapters are: (1) "The Research Project"; (2) "Participating Institutions and Their Economic Environment"; (3) "Policies and Prevailing Types of Linkages"; (4) "The Management of Interfaces"; (5) "Financial Management"; (6) "Personnel Management"; (7) "The Management of Intellectual Property"; and (8) "Conclusions." Two appendixes present guidelines for the case studies and a consultancy application form. Forty-six "boxes" highlight issues of special importance. (Contains 3 tables and 19 references.) (SLD)

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IIEP research and studies programme

Improving the managerial effectiveness of higher education institutions

Managing university-industry relations

A study of institutional practices from 12 different countries

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International Institute for Educational Planning

Managing university-industry relations
A study of institutional practices
from 12 different countries

Improving the managerial effectiveness of higher education institutions

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Managing university-industry relations

A study of institutional practices from 12 different countries

Michaela Martin

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International Institute for Educational Planning

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LIST OF ABBREVIATIONS

BITS	Birla Institute of Technology and Science
CIT	Centre for Technological Innovation (at UNAM)
CPD	Continuous Professional Development
CVCP	Committee of Vice-Chancellors and Principals
ESTC	Ecole Supérieure de Technologie of Casablanca
FUSP	Foundation of the University of São Paulo
GCF	Gatsby Charitable Foundation
GDP	Gross Domestic Product
GERD	Gross Expenditure for Research and Development
GNP	Gross National Product
HEFCE	Higher Education Funding Council of England
HEI	Higher Education Institution
HUJ	Hebrew University of Jerusalem
IPR	Intellectual Property Rights
NIC	Newly Industrialized Country
OECD	Organisation for Economic Co-operation and Development
PNGUT	Papua New Guinea University of Technology
PS	Practice School
R&D	Research and Development
S&T	Science and Technology
SMEs	Small and Medium Enterprises
SUT	Suranaree University of Technology
TDF	Technology Development Foundation
TECO	Technology Consults Ltd (Makerere University)
TUL	Technical University of Lodz
UDC	Unitech Development and Consultancy Pty Ltd
UGT	Uganda Gatsby Trust
UNAM	Autonomous National University of Mexico
USP	University of São Paulo
UWI	University of the West Indies
VCF	Venture Capital Fund

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The following report represents a synthesis of 12 institutional case studies on innovative methods and practices in the management of university-industry relations. My thanks go in particular to the authors of these case studies. While being extremely busy with directing and managing their institutions and projects in the area of university-industry relations, they could spare the time to document their experience of managing university-industry linkages with a view to sharing it with their peers. Some of the case studies produced under this project will be published by IIEP in their own right to make them fully available to the public.Without the precious inputs of the authors, this publication could not have been written.

Michaela Martin
September 1999

I. THE RESEARCH PROJECT

1. The rationale of the research project

The relations of higher education institutions with their socio-economic environment (hereinafter called universities and industries) have become a topical issue in the literature on higher education over the past 20 years or so. At the same time, this issue has moved high on the political agenda of governments, given the importance of high-level continuous training and technological innovation for the competitiveness of national economies.

Some developed countries have achieved a long-standing tradition of collaboration between universities and industry, North American countries, for example. However, in most other OECD countries, such relations have been developed and have intensified in particular during the past decade. Higher education institutions in the developing world are now very much encouraged by their governments to develop strategies in this domain. Resource constraints and a growing appeal for relevance of their activities have been pushing them more recently to give major attention to the development of policies and structures for collaboration with industry.

It should be mentioned, however, from the outset that university-industry relations comprise a wide range of very different formats. At the one end of the spectrum, ivy-league type higher education institutions may be linked to major high-tech corporations for multi-year joint R&D. At the other end of the spectrum, a small regional university may also collaborate with a small company and provide technical assistance to upgrade existing low level technology and management techniques. Obviously the management of such very diverse relations and the benefit gained form it will be very different.

Much has been said about the mutual benefits of university relations with industry. At present, the following benefits for higher education institutions are perceived from stronger collaboration with enterprises, both in developed and developing countries[1]:

- opportunity to attract additional funds for initial teaching and research, increasing financial autonomy of higher education institutions, especially if governmental core funding is tightly linked to specific academic purposes;
- co-operative research with enterprises pulling in more public funds if there are governmental project funds for collaborative research or teaching programmes;
- acquisition of or access to up-to-date equipment;
- opportunities for staff and students to become familiar with state-of-the-art industrial science and technology and management systems and enhancement of their familiarity with the constraints of industry;
- improved interaction of higher education departments and employers for the development and adaptation of (technology oriented) degree programmes;
- improved training and employment prospects for students;
- supplemental income from consulting, allowing academic staff to improve their salaries;
- enhancement of the HEI's image as a contributor to the economy.

The most important driving force for the collaboration with industry has become, without doubt, the necessity to generate supplementary income. Many higher education systems worldwide are exposed to major pressure for quantitative expansion within a context of stagnating or diminishing public resources. Research opportunities financed by the public purse are shrinking, in particular in the developing countries. Within this context, higher education institutions are increasingly obliged, and also more and more willing, to supplement the core funding from government through private sources, one of which is through contracts with enterprises.

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[1] C. Blackman and N. Segal. 1993. ***Industry and higher education***. London, New York, Philadelphia: Pergamon Press, p. 938.

Given this context, most institutions worldwide now have some type of interaction with local, national or multinational industry. The type of interaction and its degree of intensity depends on many internal and external factors, for instance the existence of:

- research and teaching capacity both within the higher education institutions (foremost, but not exclusively, in the technological, scientific and managerial areas);
- an industrial base (e.g. multinationals but also to a lesser extent small and medium-sized industry) involved in R&D activities and concerned with staff development;
- the existence of governmental policies, initiatives, financial incentives, structures or programmes to stimulate collaborative R&D and teaching programmes;
- a tradition of interaction between higher education and enterprises;
- an entrepreneurial culture within the higher education sector;
- an academic reward system and incentives for staff to collaborate in programmes with industry.

Relations between higher education institutions and enterprises relate to activities in areas both of education/training and research. Linkage arrangements that have emerged in recent years have become more and more diverse and also complex, in particular in the industrialized western countries. For the sake of classification, the following broad categories of linkage mechanisms can be distinguished:

- consultancy (conducted on a formal or informal basis);
- teaching and curriculum development (such as sandwich courses, jointly developed degree courses, continuing education courses of short, medium and long duration, exchange of staff, etc.);
- R&D activities (including contract research and co-operative and sponsored research initiated and administered by internal or external structures), some of which lead to the setting up of so-called spin-off companies involved in capitalizing on research discoveries and inventions, assisting faculty in commercializing their R&D expertise and in providing business-development assistance to entrepreneurs involved in these activities;
- others (such as regular mutual visits, jointly organized meetings, conferences and seminars, joint publications, joint participation in exhibitions and fairs, industrial support to individual students or their associations, industrial representation on the governing boards of higher education establishments, etc.).

By the late nineties, the existence of relations between higher education institutions and industry became a common and widely acceptable phenomenon. At the end of the millennium, information on such successful joint ventures is easily available as part of an information and communication strategy conducted by these institutions. However, it is much more difficult to obtain information on the formal and informal mechanisms through which institutions manage such relations. A professional management of university-industry relations is nowadays believed to be a crucial success factor for the development of sustainable collaboration. Professional management of university-industry linkages include the following aspects:

- internal or external interface structures (organizational development) which are in charge of the management university–industry linkages, in particular their organization, staffing, modes of operation and legal status as well as their control through the ***Alma Mater***;
- procedures of financial management: financial autonomy in the deployment and utilization of resources, costing of projects, distribution of generated income, existence of risk capital;
- procedures of personnel management: status and salaries of personnel collaborating in projects; development of skills and attitudes in staff for their collaboration in industry, incentives for the motivation of staff to collaborate in projects with industry; policies on the use of staff time in industry-related projects;
- management of intellectual property: existence of policies and procedures for the development and management of patents and other intellectual properties.

Even if experts agree that the above-mentioned items are of crucial importance for a successful development of university-industry linkages, they are hardly documented in the literature. The reason for this is probably because the people in charge of running internal or external interface structures, or specific projects with industry, are usually very busy managers who do not take the time to document their experience. This is why the research project was organized in 1997 and 1998.

2. Content of the research programme

The main objective of the research programme was to collect empirical evidence on innovative mechanisms through which universities worldwide manage their relations with industry. Consequently, the research project focusses on the higher education institution and its particular management concerns. Since management practices and procedures depend very much on local circumstances, such as opportunities for collaboration depending on the economic environment and enterprise structures, but also on internal policies and a particular institutional culture, it was decided to collect the empirical evidence through a case study design. Such a design would also allow to present information on such structures and procedures taking into account the particular external and internal context of the chosen institutions.

As a consequence, the IIEP identified and launched 12 case studies inviting institutional managers of university-industry relations to document innovative approaches used in the area of organizational development, financial and personnel management and the management of intellectual property, at institutional, departmental and programme levels. Such an applied approach was chosen to make available practical advice and options to other managers of programmes with industry regarding structures and processes whose appropriateness needs to be discussed in the light of specific institutional contexts. The management of innovative approaches to university-industry relations, often concerned with overcoming internal resistance, was supposed to receive particular attention.

Institutions to be chosen were those having established an important number of linkages with local, national and international industries and businesses, for instance in the teaching domain (i.e. continuing education programmes, sandwich courses, joint curriculum development), R&D, consultancies and enterprise development. They would have ideally had a formalized institutional commitment to the development of university-industry linkages, and be known for their innovative management approaches. Consequently, they could ideally serve as a role model for other institutions willing to develop their relations with industry.

Depending on the management structure of university-industry relations, authors were either high-level officials of a university or another tertiary-level establishment in charge of programmes and activities with industry. Some were also managers of interface structures with industry or managers of programmes and activities located at the departmental level. Authors received guidelines (see *Appendix I*) representing a list of possible items that could be addressed in the case studies on the management of university-industry relations. This proposed structure for case study presentation was supposed to allow for some comparability of cases.

Since each institution has its own specific history, structures and procedures, certain items were more relevant to some institutions than to others. Often programmes with industry are run in a decentralized way. Consequently, the guidelines needed to be adapted by authors to their own context and they were invited to refer to parts only of their activities conducted with industry, for instance at the departmental level or by a particular interface structure.

The objective of the research programme was also to collect empirical evidence from a limited number of innovative cases, but representing experiences from all continents and quite diverse development contexts, including a Western industrialized country, middle income countries and least developed countries. The following case studies were identified and could be prepared under the research project.

Africa

- Makerere University, Uganda

Arab countries

- University of Cairo, Egypt
- Ecole Supérieure de Technologie de Casablanca, Morocco

Asia and the Pacific

- Suranaree University of Technology, Thailand
- Technological University of Papua New Guinea
- Birla Institute of Technology and Science, India

Europe

- Technical University of Lodz, Poland
- Hebrew University of Jerusalem, Israel
- Bogaziçi University, Turkey

Latin America and the Caribbean

- UNAM, Mexico
- University of São Paulo, Brazil
- University of the West Indies.

These case studies were identified with the help of international experts who were asked to recommend innovative institutions in the domain of managing university-industry relations. Such experts were widely drawn from the network of UNESCO's UNISPAR[2] projects concerned with the development of university-industry linkages and which operates through national working groups made up of representatives from academia and from the productive sector.

Case studies were submitted and revised during 1998 and early 1999. Most authors (8 out of 11) of the case studies took then part in an Internet Forum organized by the IIEP in December 1998 and January 1999. The objective of this Forum was to revise the case study material and to collect supplementary comparative information on some crucially important issues such as: *(i)* the organization and control of external interfaces, *(ii)* the costing of projects, *(iii)* the distribution of generated incomes, and *(iv)* incentive structures for staff to engage in collaboration with industry. Those authors who participated agreed to share their professional experience and comment on that of their peers. The following synthesis is the result of all 12 case studies and includes also the findings of the Internet Forum.

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[2] The UNISIPAR programme of UNESCO aims at the creation of linkages between higher education institutions and industry. It operates through the setting up of working gorups at the national level which comprise experts from industry and universities.

2. PARTICIPATING INSTITUTIONS AND THEIR ECONOMIC ENVIRONMENT

1. Participating institutions

The participating institutions were chosen to represent the full range of types of higher education establishments. Seven out of 12 are comprehensive institutions with a wide variety of faculties (Autonomous National University of Mexico, Hebrew University of Jerusalem, Bogacizi University, Cairo University, Makerere University, University of São Paulo, University of the West Indies). The other institutions are of a specialized nature with technological orientation. The case study from Morocco is from a small tertiary education institution (technical college), the Ecole Supérieure de Technologie (EST), whose mission it is to train middle-level technicians in two-year professional courses. All but one institution, the Birla Institute of Technology and Science, India, are public higher education institutions. Both the legal status and the disciplinary orientation certainly have an impact on the capacity of an institution to engage in joint ventures with enterprises. The Birla Institute, for example, which is financed through the contributions from an industrial group and which offers training programmes in the science and technology domain, has a natural linkage with industry.

Most of the participating institutions have deep traditions, such as Bogaziçi University in Turkey, founded as an American college in 1863, Cairo University founded in 1908, the Hebrew University of Jerusalem founded in 1925 and the University of São Paulo, Brazil, founded in 1934. Most other institutions stem from the post-war period. Lodz University was founded in 1945, the University of the West Indies in 1948, Makerere in 1949 (university status), BITS in 1964 and Suranaree University only recently in 1990. Age and tradition are crucial factors with regard to the innovative capacity of an institution. It may be expected that younger institutions do not need to overcome the same level of resistance among their staff with regard to new modes of operation, such as joint ventures with enterprises, as do older, more traditional institutions. If the age of an institution is certainly an important factor, the study could not confirm this factor to be of a determining nature.

In terms of student numbers, institutions are also quite diverse. Cairo University, with 101,427 students in 1997, and São Paulo with 60,071, are mega-universities. The Hebrew University of Jerusalem with 23,800 students, Lodz Technical University with 22,500 students, and Bogacizi University, with 9,162, are medium-sized institutions. The University of the West Indies, with 6,339 students, Makerere with 6,600 students and Birla Institute of Technology with 5,600 (2800 on-campus and 2800 off-campus) are medium-sized to small institutions. Among the small establishments are the Technological University of Papua New Guinea with 1,653 students and finally, the Ecole Supérieure de Technologie of Casablanca with only 440 students. Again, one can hypothesize that the size of the institution conditions, to a large extent, the degree of administrative decentralization, as well as the scientific potential which in itself presents a potential for relations with industry. Again, the study could not confirm these hypotheses. One factor that could be identified as important has been, however, the economic environment of an institution.

2. The economic environment of participating institutions

Broad economic indicators

Institutions participating in the research were chosen to represent different types of economic environments comprising an industrialized country (example Israel), a country in economic transition from centrally planned to market economy (example Poland), several middle-income countries such as Thailand, Brazil (with huge internal disparities), Turkey, the West Indies, Morocco, Papua New Guinea, as well as several low-income countries, such as India, Egypt and Uganda. Obviously, the economic environment conditions the potential for joint activities, particularly in the area of joint R&D more than in collaborative teaching (continuous professional development, joint education, internships, etc.).

Table 1. Selected economic indicators for participating countries

Country	Population in millions	GNP (1997) per capita in US$	Average annual growth rate of GDP 1996/97	Annual growth rate of gross domestic investment 90/97	Number of domestic companies, 1996
Brazil	164	4,720	1.1	4.0	551
Egypt	60	1,180	3.0	2.7	646
India	961	390	3.2	8.9	8800
Israel	6	15,810	...	11.5	655
Morocco	28	1,250	-4.4	-0.1	47
Papua New Guinea	5	2,010	11.6	3.7	...
Poland	39	3,590	6.7	8.7	83
Thailand	61	2,800	-1.3	10.3	454
Trinidad/Tobago	1	4,230	5.5	9.0	23
Turkey	64	3,130	6.4	4.0	229
Uganda	20	320	2.3	9.9	...

Source: World Bank. 1999. *World Development Report 1998/1999. Knowledge for Development*. New York: Oxford University Press.

Table 1 shows that there is an enormous difference between the great diversity of countries which participated in the study in terms of population size, per-capita income, economic dynamism measured (however imperfectly) through economic growth rates and annual growth rates of public investment. The number of domestic companies (i.e. number of domestically incorporated companies listed on stock exchanges at the end of the year, excluding investment companies, mutual funds, and other collective investment vehicles) provides a small insight into the existing production structures, even if not directly related to the size of the workforce of these companies.

The above-mentioned national figures do, however, hide quite considerable disparities within countries. The most striking example in the group is certainly Brazil, where the State of São Paulo counts for 22 per cent of the population, but generates 36 per cent of the national GNP. The State of São Paulo is also the major source of Brazil's science and technology (S&T). It consumes 35 per cent of the national expenditure in S&T, and produces 50 per cent of the articles published in scientific journals and books, as well as 60 per cent of patents received by residents.

Indicators on scientific development

Table 2 shows the tremendous variations that exist in the potential of particular countries engaging in science and development. It is not surprising that Israel has the highest number of scientists per 1 million inhabitants (more than the USA), and four times more than Poland. All other countries for which data are available have less than 500 scientists per 1 million inhabitants. This figure seems to be partially correlated with another science and technology-linked indicator, that is the proportion of technology exports of total manufactured exports where Thailand, Trinidad and Tobago are outnumbering Israel. This indicator tells, however, only part of the truth since the total of manufactured exports is not known.

Table 2. Selected indicators on scientific and technological development

Country	Scientists and engineers in R&D in million people (81-95)	Number of patent applications filed 1995 by residents	High technology exports as % of manufacturing exports, 1996
Brazil	165	18	2,757
Egypt	458	9	...
India	151	10	1,545
Israel	4,826	30	1,266
Morocco	...	24	89
Papua New Guinea	...	4	...
Poland	1,083	11	2,598
Thailand	173	36	...
Trinidad/Tobago	240	33	29
Turkey	209	8	206
Uganda	...	...	...

Source: World Bank. 1999. *World Development Report 1989/1999. Knowledge for Development*. New York: Oxford University Press.

The above-mentioned figures point to the uneven distribution of the science and technology effort worldwide. UNESCO's World Science Report, 1998, demonstrates this by groups of countries. Statistics on science and development show that the Western industrialized countries (Western Europe, North America and Japan and the NICs) together produce 55.8 per cent of the world GNP (applying the purchasing power parity index), but they deploy 84.5 per cent of the world's gross expenditure on R&D (GERD). At the other end of the spectrum, sub-Saharan Africa produces 2.2 per cent of the world's GDP, but deploys only 0.5 per cent of the world's GERD[3]. In terms of technological output measured through the number of registered patents, Western Europe, North America, together with Japan and the newly industrialized countries (NICs) realized 97.4 per cent of the European patents and 98.7 per cent of the USA patents in the period 1990-1995. These selected figures demonstrate the extremely uneven distribution of resources and the R&D output between the industrialized and the developing countries, Latin America included.

Enterprise structures

Beyond the deployment of public resources for R&D, the structure of enterprises (number, size, economic branches, etc.) needs to be considered as a factor impacting on university-industry linkages. With the exception of the Hebrew University and perhaps the University of São Paulo, the economic environments of the other case-study subjects are characterized by a majority of small and medium-sized enterprises concentrating their activities on specific economic branches, such as manufacturing (Turkey) and textiles (Morocco). In Turkey, for instance, the SME sector accounts for 99.6 per cent of all enterprises in the manufacturing industry, and for 66.1 per cent of employment, but the SMEs' share in value-added created is just 27.3 per cent. In Turkey, the average number of employees per SME is less than three, they generally use low technology and lack skilled personnel. In Morocco, too, the majority of enterprises belong to the SME sector, and are family owned, and lack capital and trained personnel. In Papua New Guinea, the manufacturing industrial sector comprises about

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3. UNESCO. 1998. *World Science Report 1998*. Paris: UNESCO Publishing, p. 23.

50 small to medium-sized industries. The economy of the West Indies is mainly characterized by agriculture and tourism and the manufacturing sector is relatively small, with an average of 9 per cent of the region's GDP (except for Jamaica, Belize, St Kitts and Nevis). This sector is much more developed in Trinidad and Tobago, but is also shadowed by the mining/petrochemical sector.

The economic environment of the Technical University of Lodz features a policy of restructuring of the unprofitable. However, there is still a dominant coal-mining sector, with close to 120,000 jobs, that will need to be scaled down and redundancies made up until the year 2002. The heavy metallurgy, armaments, tractor, and small-scale textile industries have similar problems. At the same time, many formerly public enterprises have been privatized with major financial assistance from the European Union's Phare programme. Privatization of the economic base has already been widely accomplished, with 78 per cent of all 261,500 Polish enterprises belonging to the private sector. Also, recently, US$22.1 billion have been invested in Polish industry by foreign investors.

The economic environment of Makerere University is still predominantly agriculture based (even if its share in the GDP is somewhat declining) with an important and vibrant informal economy (with 14 per cent of the labour force employed in the urban informal sector compared to 5 per cent in the formal sector). The manufacturing sector now accounts for about 8.4 per cent of the total economic output and there are prospects that its share will grow over time. The Government of Uganda, much the same as in Poland, is currently committed to a programme of privatizing public enterprises. Among the enterprises of the modern industrial sector, mainly supplying the home market with modern technology and services, a substantial number of them are of foreign or joint ownership. Besides this sector, there is a formal industrial sector including car workshops, construction companies and consultancy services. Their particular characteristics are low technology and capital input, but high input of unskilled labour.

With regard to collaboration with universities, the SME sector faces many problems. Generally technology is imported and R&D concepts are not fully understood by the personnel of SMEs. They have difficulties in identifying their technology and development requirements. Also, governments and large-scale enterprises do little to promote technology transfer into SMEs. Collaboration between universities and the SME sector is more in the nature of technical assistance aiming at the identification of technology needs, than joint R&D.

All case-study authors mention the existence of a small sector of big enterprises. In Turkey, enterprises with more than 1,000 employees make up only 0.07 per cent of all enterprises, but they create 34 per cent of the value added. In Papua New Guinea, there are 12 medium to large industries which are partly foreign owned and managed. In the São Paulo area, which has experienced a concentration of the international car-production industry, several multinational firms have installed themselves. The Hebrew University of Jerusalem's economic environment is characterized by both a considerable number of large-scale multinational enterprises, but also a growing number (around 1,000 at present) of small, technology-based companies often created by scientific workers from the shrinking defence industry. The leading industries in Israel at present are working in the areas of pharmaceuticals, chemistry, computers, telecommunications, electronics, biotechnology, medical apparatus, etc. Many enterprises have tended to be owned by the government, the trend has been to privatize these public enterprises.

Governmental incentives facilitating collaborative activities

Nowadays governments worldwide are increasingly recognizing the important role of higher education institutions in regional and national development. This role can be considerably advanced if they are capable of establishing a sustainable and mutually beneficial relationship with surrounding enterprises. In order to foster such relationships, governments tend to play a catalysing role and put into place a number of incentive measures such as tax reduction for R&D expenditure in joint ventures between enterprises and universities, or special funds, such as matching grants, made available often on a competitive basis in particular for joint R&D ventures, or, increasingly, the creation and joint financing of technology centres or science parks located in the close environment of the universities.

Nearly all case authors mention such facilitating mechanisms. The Hebrew University of Jerusalem indicates the example of one major national programme for the facilitation of relations between universities and industry conducted by the Office of the Chief Scientist of the Ministry of Commerce and Industry. The Programme is aimed at developing generic technology through the creation of consortia between industries in various areas and university researchers.

The most complete set of mechanisms and instruments to foster relations with industry is reported from the University of São Paulo. In Brazil, there are several federal and state programmes and funds, among others a law established in 1991 providing generous tax incentives for the information technology industrial sector, and which demands, in exchange, that companies spend at least 5 per cent of their revenue in R&D. Also, there exist a number of specially designed programmes such as one by FINEP-TEC, a funding agency of the Ministry of Science and Technology, which provided soft loans to enterprises for R&D, under the condition that at least 15 per cent of the expenditure was made by universities. The universities receive a non-returnable grant of 10 per cent of the amount loaned by FINEP to their industrial partner, as a stimulus to improve their research base. An initial amount of US$25,000 was given by FINEP to 132 major public research universities, in order to lay the foundation or to improve a liaison office with industry. Other current initiatives are PRODENGE/RECOPE, which promotes research networks among engineering faculty teams and companies; OMEGA, which promotes co-operative R&D with a university involving at least two companies; PADCT III, which includes a 'technology component', providing non-refundable grants for numerous collaborative activities in the R&D area; or SEBRAE, a national non-profit organization, created in 1991, aimed at promoting small business, and, lastly, FAPESP/PITE, established in 1995 by the State of São Paulo to support research of direct industrial interest.

Turkey is another country which has put in place a considerable number of incentive measures. In 1989, the Turkish Government established a corporate tax deferment for the R&D expenditure realized within a three-year period (which is refunded up to 20 per cent of the following year's tax). In 1995, tax incentives for R&D investments were created: R&D investment could be excused 100 per cent from tax in the year that it had been spent. Also, since 1995, industrial R&D projects have been supported at different rates, depending on the R&D performance of the company over the past years. In addition, in 1991 the Technology Development Foundation (TDF/TTGV) was created, partially with World Bank funding, equally for the promotion of joint R&D, through the provision of diverse financial instruments, such as seed capital for projects which have the potential of developing Turkey's technology infrastructure.

In Turkey, another incentive mechanism for university-industry co-operation is the revolving fund system, which seems to be particularly suitable for laboratory-based research and development. It foresees high levels of overheads that, within the provisions of the related laws and regulations, have to be charged to the project owners. For example, out of every 100 per cent (plus 15 per cent VAT) deposited into the revolving fund for a particular project, 10 per cent is deducted as tax, 5 per cent is deducted for a special fund to support faculty conference travel, 3 per cent is for the use of the Rectorate, and 1 per cent is for another special fund. The expenses of the project are met from the remaining 81 per cent. About 31 per cent of what is left is set aside for the use of the unit (the department) by the project personnel, and the rest (69 per cent) is paid to the faculty involved in the project which may be subject to 25-30 per cent income tax, assuming that there are no expenses involved in the project and the personal income taxation level of the faculty is 30 per cent. For every 100 per cent that the faculty is to receive, about 25 per cent plus 15 per cent VAT has to be paid to the university by the project owner. However, this system is subject to very tight rules and regulations, making it very difficult to effectively utilize the funds created.

In Poland, under the former socialist governments, higher education institutions had particularly strong linkages with enterprises, since the co-ordinating ministry obliged the institutions to entertain such relations for joint R&D and teaching. However, more recently, such linkages have been dismantled with the privatization of formerly public enterprises and the drop in state funding for institutions. In 1991, the State Committee for Scientific Research (KNB) was created, which manages the national programmes and funds for the stimulation of university-industry linkages. Projects in the area of applied research are funded 50 per cent by industry and 50 per cent by KNB. Also, in 1997 a State Technology Agency (ATT) was created to promote innovations in industry, especially in the SME sector. ATT offers low-interest loans for the development of new promising production processes and products, but it acts on a cost-recovery basis. Poland participates also in a number of R&D programmes financed by the European Union, which provide funding for transnational consortia of higher education institutions and private enterprises.

An important number of incentive measures can be put in place by the government through an appropriate legislative framework for the management of funds generated through projects with industry. In many countries such funds have to be forwarded to the central budget of the institution or even the Ministry of Finance, in which case there is no motivation for departments and individuals to commit themselves to collaborative projects with industry. The case study from Morocco, the ***Ecole Supérieure de Technologie*, *Casablanca,*** reports a recent change in the national framework for financial management of university-industry relations, which is the ***hors compte*** budget. This measure allows institutions to manage the funds of an industry-related project in a separate account and in a more autonomous way. In particular, institutions may generate income and use it in a much more flexible manner for the remuneration of university staff who are active in project management. The rules associated with the account, however, oblige the project managers to refund 10 to 30 per cent of their surpluses to the general university budget for overhead costs.

Another initiative reported in the Moroccan case study is the creation, in 1995, of the so-called ***Pôles de Compétences Qualité***, one of which was created in the Casablanca region. They bring together a network of several higher education institutions with technological orientation, and the national union of metallurgic, mechanic and electrical industry, who have established a jointly run centre for the testing, measurement and control of materials. The ***Pôle*** has established itself as a non-profit organization at the service of enterprises of the Casablanca region. Its main objective is not to generate resources, but to train young scientists and technicians in a real work environment.

In the case of Makerere University in Uganda, both the government and the donor community play a facilitating role. Government, until recently, financed living expenses of engineering students in industry, while industry was responsible for funding the materials that they used during their internship. In 1994, the Gatsby Charitable Foundation (GCF) from the United Kingdom, a non-governmental organization, provided seed money to the University of Makerere for the support of the SME sector in Uganda. With this seed money a revolving fund was set up; a network of enterprises linked to the Faculty of Technology at Makerere University could be created and student and staff exchange between those associated SMEs organized.

The above-mentioned account of mechanisms and support structures put in place by governments as a part of their national science policies, or the donor community for LDCs, demonstrates that they have an important role to play in the facilitation of university-industry relations. Their role is in particular to put in place an enabling administrative framework, which allows institutions, departments and individuals to benefit directly from the financial return of their work. Second, governments in many countries have made available project funds, such as matching grants, or they have created tax incentives which make it attractive for enterprises to collaborate with public entities such as universities. Finally, many governments, be it at the national or regional level, have created programmes for the setting up of support structures, or interfaces, such as liaison offices, incubators, innovation centres or science parks through which collaborative activities are channelled. Such support structures play a crucial role in the day-to-day management of university-industry relations, as will be seen in Part 4.

3. POLICIES AND PREVAILING TYPES OF LINKAGES

1. Strategic management of university-industry linkages

Relations with the private sector have in most countries already a long-standing tradition. But they have been, and often still are, the result of particularly dynamic staff who have a particular professional interest in them. As a consequence, most university-industry linkages have developed in a bottom-up manner. Nowadays it is acknowledged that one of the crucial success factors in the management of university-industry linkages is the availability of an institutional strategy for the development of such relations, for instance laid down in a strategic planning document, a development plan or any other written statement of policy. Several of the case institutions, i.e. the Hebrew University of Jerusalem, the University of São Paulo and Bogaziçi University, have adopted a documented, centralized and structured approach. In an internal planning document, the Rector of the University of São Paulo has put into writing that the development of university-industry relations is a policy priority. Bogaziçi University mentions the existence of a strategic plan. In 1996, a sub-committee on technology transfer prepared guidelines for a more focused orientation of activities, such as "choose high-tech issues for consultancy rather than routine tests for standard practices of projects". Indeed, strategic management of university-industry relations implies not only the formalization of policy priorities, but also top-level management support which is, in particular, necessary to back up initiatives emanating from the academic departments.

In all but the above-mentioned other institutions, relations with the socio-economic environment depend, however, widely on the particular dynamism of certain individuals, often teaching personnel with working experience and personal contacts in industry. As a consequence, institutional policy is not formalized in an institutional planning document and measures to foster university-industry linkages are generally concerned with creating an enabling environment and the setting up of supportive structures, such as internal or external interfaces.

2. The development of university-industry linkages prior to the early nineties

Most case institutions mention that the majority of the existing relations with industry have been put into place since the early nineties and that a more systematic approach and supportive structures and procedures have been developed since then. The driving forces behind this trend are:

- growing overall privatization of higher education and a move to the market;
- privatization of public enterprises;
- declining public resources for higher education and especially the need to complement staff salaries and to obtain research grants from industry;
- the establishment of a modern sector of enterprises, of which many are concerned with technological development, and the improvement of quality of research and scientific work within industry itself; and
- the existence of national incentives for developing such relations (see above).

At the Hebrew University, the University of São Paulo, the University of the West Indies, Papua New Guinea Technological University and the Faculty of Engineering of the University of Cairo prior to 1990, there existed already numerous linkages, both in the teaching and research areas. Whereas everywhere else there is a trend of increasing the number of linkages with industry, the Technical University of Lodz reports that the density of relations has gone down since the change of regime in 1990, due to the introduction of the liberal market system and the decline or privatization of public enterprises. More recently such linkages are being established with privatized enterprises, often backed up by national or international donor resources.

The following types of more traditional linkages which existed prior to the early nineties were mentioned in the case studies:

In initial training

The most common type of linkage between universities and industry is industrial placement periods for the training of technologists and engineers which are mainly, but not exclusively, present in all institutions. Makerere University reports that, traditionally, it has been a faculty requirement that every student pursuing a degree in any engineering discipline must undergo a specified period of industrial training in a recognized industrial establishment (usually 10 weeks at the end of each academic year). However, problems related to both the institution's placement and supervisory capacity and the deteriorating public enterprise sector put a stop to the effectiveness of this placement scheme, particularly in terms of its perceived usefulness by students, staff and enterprises.

The case study from the University of Lodz indicates that student placements in the engineering field were a rather common phenomenon under socialist rule and that they were performed on the basis of Ministry disposition. This placement scheme has come under considerable strain with the restructuring of enterprises. Permanent staff exchange and part-time jobs in industry of academic staff were forbidden under socialist rule. University staff could only be invited as experts called upon to solve a particular problem. There were also the extramural evening and distance-education courses for professionals. Continuing education was performed through postgraduate courses for engineers from industry, and technicians.

Student placement schemes are common practice nowadays, in particular in the technology domain, but they traditionally also pose numerous problems. Often, they are not well integrated in the overall curricula, badly supervised by untrained mentors in industry, and often not well followed up by the academic staff, more concerned with theoretical teaching than with practical application of knowledge. Despite the existence of a placement scheme, there is indeed a dichotomy between the academic and the industrial spheres to the detriment of the students' learning. A very innovative approach to this problem is provided by the Birla Institute of Technology, a private higher education institution sponsored by industry, with its practice school scheme, which we will describe more fully under the next section.

With regard to continuous professional development (CPD), Bogaziçi University from Turkey reports that, prior to 1990, the university was involved in continuing education activities, mainly conducted by the faculty of engineering. The School for Advanced Vocational Studies periodically offered short certificate courses in the area of computer sciences, which provided the university with an appreciable source of income. The CPD activities have been greatly enlarged since the early nineties and they have grown into a major source of income at Bogacizi University.

In collaborative research and development (R&D)

The University of the West Indies and Cairo University also have a long-standing tradition of conducting joint research with socio-economic actors in highly specialized areas. Both institutions have set up specialized research centres for this purpose. At the University of the West Indies, particularly in the agriculture, medical and technological domains, several specialized research units, often set up with some donor support, were created to conduct research, do training and provide services for particular communities. Such units, created already before the 1990s, comprise the Cocoa Research Unit, the Caribbean Agricultural Research and Development Institute, the Centre for Advanced Training and Research in Fertility Management, the Tropical Metabolism Research Unit, Centre for Marine Science, and the Caribbean Industrial Research Institute.

In the case of the Faculty of Engineering of the University of Cairo, some internal interfaces, called 'centres' had been created in the period before 1990. Such centres offer very specialized services, mainly in the R&D domain, but also comprising services such as measurement and testing activities. Until the early seventies, the Faculty of Engineering at Cairo University had only two civil engineering laboratories and one workshop providing services for outsiders. In 1974, a specialized centre was established to provide technical services to industry. During the late seventies and eighties, three more centres, the Research and Maintenance Centre for Biomedical and Scientific Equipment, the Energy Research Centre and the Centre for Software Development and Application, were established. As the number of centres grew, they adopted an increasingly focused orientation to address more diverse industrial needs. All these centres have now become full business centres.

In the case of the University of Lodz, again as part of central planning and control by a sectoral ministry, every state company had to spend a given budget for R&D activities to be conducted jointly with the universities and the Academies of science. This mechanism provided some extra gratification for university staff, some new equipment for departments and new ideas for university research. However, many results of such R&D were not applied in practice. Also, under socialist rule, much of the R&D was conducted in the Academies of Sciences with 9,000 employees, as well as the 298 state R&D institutes, which employed 60,000 people.

In public relations

If there is no tradition of collaborative programmes and activities conducted by industry and universities, it is often necessary, as part of a sensitization strategy, to inform potential enterprises that the higher education establishment has interesting things to offer. Such a sensitization strategy is mostly implemented through the organization of meetings for actors from both spheres to gather at particular events and to acquaint each other with ongoing activities and programmes. For this reason, the *Ecole Supérieure de Technologie* of Casablanca has been organizing numerous so-called *Journees Portes Ouvertes*, days during which industries and enterprises can visit the institution and discuss, in a non-committing way, common concerns. The school has also participated in scientific fairs, and in as many other professional meetings as possible, to publicize the activities and products of the *Ecole*.

The Papua New Guinea University of Technology, prior to 1990, conducted biennial national seminars designed to encourage co-operation between the universities and industries, private businesses, government departments, and the community at large. Various departments of the university organized national and international seminars in the area of their expertise. Industries, private businesses, government departments and members of the broader public were regularly invited to these lectures, seminars and conferences.

Existing linkages since the early nineties

All institutions participating in the research mention that the volume of their relations with industry has considerably grown over the nineties.

The University of São Paulo indicates that at the beginning of the nineties the university had about 300 formal ongoing agreements (without mention of the placement schemes), whereas at the end of the nineties, this number had grown to 500. But relations have not only become more numerous over the past decade, they have also been broadening in scope to embrace new areas of collaboration. The case studies mention innovative experiences with regard to all types of linkages, i.e. co-operative education, practice schools and continuous professional development, joint R&D, long-term consultancies, commercialization of university R&D products through licensing arrangements, collaboration with the SME sector and other enterprise development etc. Some examples mentioned in the case studies are presented below.

In initial training

As already mentioned above, internship programmes for students belong to the most traditional type of linkage, but as mentioned above, they often encounter manifold problems if they are not well organized and managed. BITS in India has developed an innovative programme of so-called 'practice schools' (PS) which follow a similar scheme offered by the Massachusetts Institute of Technology. Practice schools are established in a number of enterprises which agree to collaborate with BITS staff on a regular basis. At the same time, students join the practice schools on pre-agreed tasks and they are supervised jointly by BITS teaching staff posted at the enterprise and the staff of the enterprise.

Box 1. Practice schools at Birla Institute of Technology, India

The BITS 'practice school' method of education is an attempt to institutionalize the process of bridging the gap between theory and practice. Just as a medico undergoes internship in a teaching hospital during his educational years, all students of BITS are required to practise their professions by working on real-life problems at the industrial set-ups during their educational years. This is accomplished by establishing classrooms in an industrial environment known as 'practice school stations'. Practice school programmes differ from the conventional practical training programmes and sandwich scheme in the sense that the students work on projects which are of direct interest to the organizations; the work of the students at the PS stations is monitored and evaluated by the resident faculty; these courses are properly integrated into the degree programmes.

The PS programme for the integrated first-degree programmes has two components, namely, PS-I and PS-II. PS-I is attended by all the students during the summer vacation following the second year. Students attend their PS-II in either of the semesters of the final year. Dual-degree students can opt for PS-II in both the semesters of the final year. For higher-degree students there is a single component called 'practice school' for higher degree and it is attended during the final semester of the higher-degree programme.

PS is an optional programme. However, due to its immense popularity, almost all students opt for the practice school stream. Students in this stream spend three months more time than the normal student and receive a degree with a tag 'With practice school'.

Practice School-I is implemented at the end of the 2nd year during the summer. It is an exposure-oriented course and is of eight weeks' duration. The aim of this programme is to train the student in the art of information collection, documentation, retrieval and presentation. The *weightage* of this course is 5 units and the grade obtained becomes the part of the transcript. This Practice School-I programme is implemented at large industrial complexes which give enough scope for the students to study the multifarious activities of the organization.

The Practice School-II programme is of 5.5 months' duration, operated round the year, and is attended by the students in the final year. Students across all disciplines are divided *into halves* so as to ensure continuous manpower supply to the industry, while one half attends practice school in the first semester, the other half attends it in the second semester. One distinguishing feature of the PS-II programme is that the students work on the projects which are of interest to the host organizations. No project is created for the sake of training the students. The students get trained while working on the ongoing developmental activities of the host organization. Naturally, the identification of these practice assignments is central to the concept of the practice school method of education. BITS faculty residing at the organization starts identifying these projects by having discussions with various persons in the industry almost four months before the students arrive at the station. There must be at least one person from the industry who is interested in the project and who would be associated as a consultant during the execution of the project. The student will be working under his guidance throughout the period of his stay at the PS station. Since the students are contributing to the professional well-being of the organization and consequently to the productivity, every student is paid an out-of-pocket allowance during the Practice School-II programme.

The co-operative education scheme practised at Suranaree University of Technology (SUT) is similar to the practice school scheme of BITS in that the internship is an integrated part of the training course. Another similarity is in its international approach. Like the BITS, which sends students to Singapore and the USA, a limited number of students are placed each year i0n companies or public enterprises abroad. Over and above, co-operative education at SUT is an integral component of all training programmes, not only for engineers and scientists.

Box 2. Co-operative education at Suranaree University of Technology, Thailand

Co-operative education is considered to be an integral part of Suranaree University of Technology's undergraduate curricula. It is an important innovation in the higher education of Thailand initiated by SUT. This aspect of education combines the academic experience of the student with actual working experience of the student in an industry. The student works as a full-time employee at the work site. After beginning studies in his or her major field, he or she is required to take two trimesters of co-operative study, each worth six trimester credits, resulting in a total of 12 trimester credits. The student is under close joint faculty and work site supervision and evaluation; the performance must be satisfactory. Hence, co-operative education assures professional preparedness in addition to academic and basic work skills, which are necessary traits for the workplace.

The Co-operative Education Project has initiated co-operation with the private sector in areas such as research experimentation, consultation, production improvement, etc. More importantly, the university's curriculum can be adapted to society in this age of increasing academic realization of global requirements.

The process

1. *Work terms*

Work terms begin in January, May and September and normally continue for four months with a minimum of 13 weeks duration. The availability of co-operative students throughout the year gives employers the option of filling positions on a short-term or an ongoing basis.

2. *Job descriptions*

Approximately four months before the start of a work term, employers are asked to provide job descriptions, outlining duties and responsibilities, education and experience required, salary range and location. The job descriptions are then posted at the Co-operative Office for students to consider.

3. *Student placement*

Students select jobs which interest them. Cover letter and resumes are then forwarded to employers who choose appropriate applicants. If the employers require, job interviews may take place on university premises about two months before the work term begins. Upon completion of the selection process, employers rank the students they would be prepared to accept and students also submit their order of preference for positions. The co-operative co-ordinators then negotiate the best possible match of jobs with students, attempting to satisfy the requirements of both groups.

4. *Salaries*

Salaries paid to co-operative students are determined by the employer within each organization's wage structure. As students progress through their programmes and assume more responsibility on work assignments, it is expected that their salaries will increase as merited.

5. *Student visits*

During each work term the Co-operative Faculty adviser and/or the co-operative co-ordinator visits the student and employer at the work site. The purpose of this visit is to discuss the student's work assignments and progress, as well as career and academic plans.

In addition, the site visit fulfils another goal of co-operative education – that of closer relationship with the employer community. Feedback on the quality and relevance of academic programmes and course content, as well as information on current research and development is exchanged.

6. *Work performance evaluation*

Near the end of work term, employers are asked to complete, and to discuss with the student, a final evaluation of overall performance.

7. ***Work report evaluation***

Students are required to complete a work term report. The student will discuss the specific details of this assignment with the employer. However, it can be described in general terms as an academic paper on a topic which is of value to the employer. Employers are asked to review this report and comment on it.

The Project, at present, is overseen by an Advisory Board consisting of 25 members, 21 of them are from outside of the university. The university membership consists of the Rector, two Vice-Rectors and the Chief of the Project. The Council meets once a year.

The Project is run by an Executive Committee consisting of ten members, chaired by the Rector with the Vice-Rector (Academic Affairs) as the Vice-Chairman and the Chief of the Project as the Member-Secretary and fourrepresentatives of four institutes, one representative from the Academic Services, one from the Student Affairs Section and one staff member from the Project. The Executive Committee meets once a month.

The Project has eight staff members, one chief, five co-operative co-ordinators and two assistant co-ordinators.

In continuous professional development (CPD)

In addition to an opening up and adaptation of initial training structures, institutions are increasingly involved with the provision of continuous development for professionals of industry. CPD has perhaps become the most common form of linkage with the socio-economic environment, since higher education institution have a definite comparative advantage in this area over all other providers in this domain, given their longstanding expertise in advanced education and training. Second, continuous professional development allows to gain considerable sources of income. All institutions that have participated in the case study research mention initiatives in this domain, mostly in the area of engineering sciences and management development. Bogaziçi University, for instance, has developed a wide range of CPD courses of different duration and which are organized either by the University Foundation, one of its subsidiaries or directly by the academic staff.

Box 3. Continuous professional development at Bogaziçi University, Turkey

Four different kinds of activities fall under continuous professional development carried out by Bogaziçi University in Turkey:

MESSE seminars: these are one to three-day seminars on popular subjects organized by a company owned by the Bogaziçi University Foundation (BUVAK), called KAMPUS. It organizes everything connected with the seminars, including placing advertisements in the national dailies, leaving to the lecturer only the preparation of training materials. The lecturer receives a fixed daily fee and the profit or loss goes to KAMPUS. Typical seminar titles have been *finance, strategic management, environmental management, human resource management, economic and political developments in Turkey*, etc.

BU Foundation certificate programmes: These are 6- to 60-day events, the programmes are controlled by the academic council. These are underwritten by the Foundation and the lecturer involved in the programme receives a fixed daily fee for covering a part of the well-defined course outline.

BU Certificate programmes: these are 6- to 30-day events controlled by one of the academic bodies of the university. The budget is administered by the Director of the programme, financial transactions being carried out through KAMPUS, as well as through the revolving-fund system.

Courses and seminars on a specific topic: These are events proposed by faculty members as one-time events on a specific topic, lasting usually one to two days. The promotion, the administration and the budget control are carried out generally by the proposer. KAMPUS and the revolving-fund system intervene only in the financial transactions.

Similarly, the Birla Institute of Technology and Science started already in 1979 activities in continuous professional development by launching the M.E. (Collaborative) programmes in project engineering and professional production. Activities in this domain were boosted up within the context of a new governmental education policy, emphasizing the need for introducing distance learning in science and technology areas. Since then, BITS has multiplied the number of distance education programmes specifically designed to fit the human resource development plans of collaborating enterprises. Distance education was felt to avoid dislocation of the employee from the working place and to ensure immediate applicability of academic knowledge to the workplace. Very similar to the above-mentioned practice school scheme within the initial training domain, the continuous professional development programmes of BITS try to achieve the best fit between an academically sound and certified training provision and its applicability to the work place.

Box 4. Human resource development through distance education at BITS

In 1988, BITS decided to expand its involvement in the human resource development programmes by launching the following off-campus distance learning programmes (DLP).

- *Master of Vocational Studies (MVS)* in Computer Operations & Applications and in Information Management at the Integrated First Degree level. These programmes were primarily designed to develop manpower that can effectively plan and use the emerging computer and information management technologies in their work place. These programmes were usually targeted at the development of secretarial, clerical and operational manpower in organizations.
- *Bachelor of Science (BS)* programmes in Technological Operations and Pharmacy Operations for the manpower development of diploma holders in engineering and pharmacy, respectively.
- *Master of Science (MS)* programmes in Technological Operations and Pharmacy Operations, designed to suit the manpower development needs of engineering and pharmacy industries.

From a very modest beginning in 1988, the BITS DLP programme became extremely popular with many industries coming forward to integrate their human resource development programmes with an academic programme of BITS. The Senate of BITS (which is the highest academic decision-making body) authorized the conduct of any of its on campus programmes off-campus for the manpower development of industries. In addition, the institute has also designed specific educational programmes to suit the requirements of specific industries.

The teaching method of these educational programme centres around the work environment where the learning takes place. The diversity of the various educational programmes conducted off-campus, the diversity in the needs of the collaborating organizations, the diversity in the profile of the candidates and the structure of the educational programme requires some variation and fine tuning in the teaching method. However, there exists some underlying unity in the teaching method employed in these diverse programmes.

- All these programmes are conducted off-campus in the work environment of the candidates.
- There is systematic integration of the needs of the work place with the academic requirements of the degree programmes.
- Stress is put on self-learning, supported by periodic lectures by faculty, structured reading guides, interaction with mentors in the work spot.
- Each student has a mentor from among the senior officers from the industry to guide him in his learning.
- Intensive contact programmes by BITS faculty and other resource persons from the industry are looked after.
- Each of the courses has a BITS faculty as instructor either from the campus or located in the locale of the organization.
- Learning materials include standard textbooks published, course material specifically developed by BITS faculty and other resource persons, other documents available in the industry, video films and computer-aided instruction.
- Assignments for each of the courses are drawn from an area closely related to the work environment of the student.
- Each of the programmes require a student to work on a semester long project as part of a thesis, dissertation, internship or in-service training. These are usually areas of direct interest to the development goals of organizations.
- Academic monitoring is done by BITS faculty in the locale as well as the nucleus members of the Distance Learning Programmes Division of BITS on-campus.
- Facilities exist for the students to avail of flexibilities like choice of pace, remedial courses and marginal deficiencies.

The evaluation methodology incorporates some unusual evaluation schemes. The rigours of these components are ensured to be comparable to those programmes on-campus. Unlike the traditional evaluation components employed by universities on-campus, these programmes have components that bring out certain personality traits of the students

like leadership qualities, team work, capability to handle open-ended situations, etc. Some of the salient aspects of the evaluation methodology are mentioned below.

- **Continuous evaluation, with certain components conducted by the BITS faculty and mentors.**
- **Involvement of resource persons/mentors from the organization in the evaluation process.**
- **Assignments drawn from areas relevant to the work environment of the student and of importance to organizational development**
- **Evaluation components based on group discussions, seminars, case studies, group projects, etc.**
- **Written examinations during the mid-semester as well as comprehensive examination at the end of the semester.**
- **Written examinations are mostly open-book, thereby negating the role and importance of rote learning and memory-based learning.**
- **Professional practice and/or technical communication course as a compulsory component of every higher degree programme.**
- **A semester-long thesis, project work or internship for integrated first degree programmes, dissertation or internship for higher degree programmes. For these courses, the evaluation would consist of written reports, seminars, group discussions, viva voce, etc.**
- **Relative grading based on performance in all components of evaluation during the entire semester.**
- **Letter grades based on performance and an equivalent grade point on a 10-point scale.**
- **Minimum academic requirements stated in terms of grades in courses as well as cumulative grade point average.**

In collaborative R&D

Since the examples provided from the case studies in the domain of joint R&D are extremely rich, we will present a limited number of illustrations of present types of linkages and modes of operation, as follows:

The Hebrew University of Jerusalem has created a subsidiary for the commercialization of R&D results, called Yissum. This subsidiary operates widely through the 'licensing' of knowledge created by the researchers of HUJ to private firms, but it is also involved in the negotiation of joint ventures with private actors for the exploitation of such results on a temporary basis.

Box 5. Commercialization of R&D products at the Hebrew University of Jerusalem, Israel

The main mode of operation for co-operation between the Hebrew University of Jerusalem and industry is still 'research and licensing agreements' where research results (whether patented or not) are licensed to interested parties in industry. In return, the industry finances continuing research in this field at the university, commits itself to develop products that will be the outcome of the project, and gives a firm commitment to pay the Yissum Company royalties.

Another mode of operation is 'services to industry'. In this case, the industry purchases some research services, mainly analysis, testing, etc. and receives the results for its use where new know-how is not being generated, thus there is no licensing required.

Another mode of operation is to form a new joint venture with industry or with entrepreneurs or venture capital funds. In this case Yissum and the partner create a new enterprise owned by them and grant exclusive rights to the new joint venture enterprise to license research project/invention/patent, developed by the university researchers.

The other party in the joint venture finances the activities of the joint venture, including further research of the said project at the university laboratories. Yissum takes an active role in the routine management of the new joint venture at the early stages and steps back as time passes and as the project develops into a product. At the stage where the product is produced and sales begin, Yissum will look to sell its shares and to invest the income in a new project, while it continues to receive royalties from net sales.

Thus the Hebrew University has developed a unique and very effective tool by creating a wholly-owned subsidiary to foster the relation between researchers and industry.

At the Faculty of Engineering of the University of Cairo such interface structures do not exist. It appears that at this institution, R&D projects still very much depend on the personal contacts of researchers with local industry. However, projects based on individual contacts often lead to long-lasting collaboration.

Box 6. Collaborative R&D at the Engineering Faculty of the University of Cairo, Egypt

The Egyptian companies do not generally have their own R&D centres. The universities and their related research centres do have research facilities that can be used to develop solutions to meet industry's needs. There are many exemplary projects going on these days between the university and the local industry. One example is a collaborative project conducted with the aluminium industry in South Egypt.

The Aluminium Company of Egypt, known as EgyptAlum, is an average aluminium smelter on the international norms size-wise. The concept of *research and development and continuous improvement* is well accepted by the management of EgyptAlum. A good number of research and development teams made of faculty members and industry personnel are active in different parts of the smelter. The algorithm of the process control for the calciner was developed by a university team which supervised the wiring and installation of the computers. As a result, the productivity of the calciner has increased. Besides, there is evident improvement of the working conditions. The same applies to the controller and magnetic stirrer of the caster. The long-term research and development project is associated with the aluminium reduction cells.

An interdisciplinary team made of faculty members of the departments of electrical, mechanical, and metallurgical engineering of Cairo University started working with EgyptAlum in 1981. Since then, the relation has continued to develop. The relationship over 16 years has been maintained, despite the fact that top and middle management of EgyptAlum changed during that period. This continuity is because the management of the company has felt at all times the positive contribution of this co-operation with the university team. Definitions of objectives and follow-up were and still are basic items in the contracts. The objectives of the team have changed over the past years, but may be put into three categories as follows:

- to realize energy conservation through process improvement;
- to model electro-magnetics, fluid flow and thermal behaviour of the cell;
- to further develop the cathode.

The university team for this project has renewed its capabilities and personnel to spread the practical and engineering touch of the faculty to all facets of the project.

Many benefits could be obtained from this relationship: improving teaching provision, acquiring up-to-date PCs and laboratory facilities. Another important benefit is the scientific and technical publications that develop out of these programmes. Output of this work has allowed the university staff and employees of EgyptAlum to participate in national and international scientific and technical gatherings. These technical forums were one of the publicity forms to announce the results of this relationship, which is considered by the scientific and industrial communities as a success story.

In enterprise support and development

A somewhat new function of collaboration with industry has been emerging more recently in many developing countries: support to or development of small and medium-sized enterprises (SMEs). As we have seen earlier, such enterprises form the majority of enterprises in most countries and they even occupy a larger share in most developing countries. Traditionally the SME sector has not been of great interest to higher education personnel, since the SMEs do not have any R&D capacity comparable to the universities, and their developmental needs are generally not of particular interest to academic staff. Given the fact that SMEs are increasingly considered as the most important engine for economic growth and employment, they have also moved higher on the agenda as partners of higher education institutions. Special programmes for their enhancement have been put in place more recently by most governments worldwide.

At the University of São Paulo, which has a somewhat traditional outreach to its socio-economic environment, new focal points such as the SME sector and high-tech enterprise development have been developed and are described in the case study.

Box 7. Small enterprise development at the University of São Paulo, Brazil

As a result of a challenge posed by the Union of Small Industries in the State of São Paulo (known by the acronym in Portuguese as SIMPI), USP created in September 1991 a new user-friendly interface to facilitate access of small companies and entrepreneurs to its body of knowledge, and to the university staff. This interface has become a highly successful service, called Disque-Tecnologia USP ('Dial Technology'). It already provides technological and managerial support to 15,000 companies and entrepreneurs. It is interesting to note that a sizeable portion of the support is provided by undergraduate and graduate students, under supervision. Several spin-offs have been established, among others 'Atual-Tec' – a continuing-education programme aimed at small companies, and 'Clip Tecnologia' – a radio programme to disseminate technological knowledge. This model has been replicated in 16 other institutions in Brazil. The São Paulo State branch of SEBRAE has always provided invaluable financial support to this initiative.

A special initiative for undergraduate students has been created during recent years, the so-called 'junior enterprises' – a model, adapted from the French experience, by which students of a certain course or school establish and operate a professional services company focused on their area of expertise. Some of these enterprises have developed a wide range of projects to industrial clients.

In addition, entrepreneurship is stimulated through the organization of regular courses, continuing education programmes, and business incubators. The most recent is CIETEC, an incubator established in its main campus area, with the partnership of the Institute of Nuclear and Energy Research (IPEN), the Institute of Technology Research (IPT), SEBRAE – São Paulo and the State Secretary of Science, Technology and Economic Development.

For agribusiness a model programme of co-operation between USP and agribusiness has been established during the past five years by Fundação Instituto de Administração – FIA, a foundation connected to the Department of Management of the Economics, Management and Accounting School. Its acronym in Portuguese is PENSA (in Portuguese, 'Thinks'), and stands for Programme of Agribusiness Studies. It has become a national reference and meeting point of enterprises, government and academia interested in developing strategies for this most important economic area in Brazil.

A very interesting initiative of providing support to small and medium-sized enterprises has been reported from the University of Makerere, Uganda. The Uganda Gatsby Trust, through the Faculty of Engineering of the University of Makerere, offers an integrated set of services to the SME sector of loans and advisory services by staff and students, partially through student and staff placements. This allows the Faculty to transfer their knowledge directly to the SME sector where it is most needed for local economic development.

Box 8. The Uganda Gatsby Trust initiative at the University of Makerere, Uganda

Uganda Gatsby Trust (UGT) was established in the Faculty of Technology, Makerere University, in 1994 following generous seed funding from the Gatsby Charitable Foundation (GCF) in the United Kingdom. The mission of the UGT, which is a non-governmental organization, in Uganda is to "assist in developing the technological base of the small-enterprise sector in the country and enable the growth of such enterprises". UGT organizes the following activities:

1. *Training courses*

The Faculty staff organize tailor-made training courses for managers and artisans of small-scale enterprises to address managerial and technical skill deficiencies.

2. *Business advisory services*

UGT sends staff members to offer extension services to identified interested enterprises with the aim of diagnosing their problems and formulating solutions and preparing well-articulated and costed business plans for the enterprises.

3. *Student attachments*

UGT enables engineering students to be attached to small-scale enterprises for their industrial training period. This enables them to appreciate the problems and potentials of the small-scale sector. Hopefully, some of them will start up micro-enterprises upon graduation.

4. *Student projects*

UGT supports final-year engineering students to design and produce appropriate prototypes. The hope is to transfer the technology developed to the industries.

5. *UGT clubs and revolving fund*

UGT set up Gatsby Clubs in selected towns to enable and facilitate constant interaction between UGT members within a given club; UGT has set aside some funds which are lent to Gatsby Club members. The lending, which is done through the 'Uganda Co-operative Bank', is based on peer-group pressure. For a second loan, the enterprise should be able to borrow from the Bank, like any other regular customer.

The above-mentioned illustrations of university-industry linkages demonstrate that the scope of activities is widening and their density is growing. This is true for all case institutions, wherever they are located and whatever their economic environment. Collaborative activities in the area of initial training and continuous professional development such as short or long courses and collaboration in the R&D domain have by now become a tradition or are developing rapidly. The collaboration with the SME sector in general, and enterprise development in particular, has been moving to the fore more recently. It is in particular this domain that allows higher education institutions to have an immediate impact on local economic development. However, collaborative projects with SMEs still need to overcome a certain number of serious obstacles. They are not always professionally rewarding, in particular if the value and incentive system of the university is still very traditional, as is the case in most countries. Also, they may not be of academic interest to research personnel in a higher education institution who are more interested in projects that can lead to publications or the development of patents. As a consequence, it is in particular in this domain that national or regional governments put in place financial incentives in order to facilitate collaboration which is most often some form of technical assistance to the SMEs. With regard to joint R&D, it is most frequently found between university departments and large multinationals or public enterprises. As a result of the relatively small size of the formal sector in most developing countries, and the tendency of multinationals to import technology, there is at present only a small potential to develop collaborative projects in the R&D domain beyond a limited, yet widening scope.

4. THE MANAGEMENT OF INTERFACES

The literature on the interaction of higher education institutions with enterprises points out the importance of a continuous, long-term effort in the setting up of a relationship which is of benefit for both institutional partners, the higher education establishment and the enterprise. There seems to be a developmental pattern underlying the progressive structuring of working relations. After an exploratory phase characterized by informal and ad-hoc collaborations, often organized at the personal or departmental level, higher education institutions tend to adopt more structured approaches which are formalized in some kind of organizational development, be it through the creation of a post, such as a Pro-Vice-chancellor in charge of extension services, or the setting up of a specific department concerned with continuing education or finally the creation of an external interface, for the commercialization of university products.

Informal links of individual academics with enterprises have been, and are still, current practice in many higher education institutions, even those that have institutionalized their relations with the private sector. Such informal links can be conducted on an ad-hoc basis or continue over quite a long period. They may consist of informal contacts or be based on a contractual arrangement. If they are directly related to the professional speciality of the staff member of a higher education institution, they can be very useful in enriching his/her experience and contribute to the updating of a scholar's knowledge.

The most developed organizational models for the management of these relations are to be found in institutions located in a market-orientated environment and which enjoy simultaneously a high degree of autonomy.

In many countries, such an approach has been strongly supported by national governments (or by the donor community in the case of LDCs), which have a keen interest in technology transfer and continuous professional development as a means to upgrade the international competitiveness of national economies. Also, given the context of financial stringency, many institutions worldwide have themselves been increasingly eager to develop policies, structures and procedures which allow them to generate income and to increase their financial autonomy.

1. Functions and organizational structures of internal interfaces

In all case institution such an institutional commitment to develop relations with industry has materialized through some form of organizational development, such as the creation of posts, for instance for a Pro-Vice-Chancellor for extension services, and the setting up of specialized internal support structures for the development of relations with industry. An example of such internal support structures has been presented by the University of São Paulo.

Box 1. Internal interfaces at São Paulo University, Brazil

The Central Council for Culture and University Extension and the Pro-Rector for Culture and University Extension provide the policy and general guidelines - for instance, what constitutes a continuing education accredited programme. Each school has its Commission for Culture and University Extension, which is a locus for local guidance in matters pertaining to co-operation with industry, and with other entities in society at large. The Pro-Rector supervises 14 extension centres, some of which are involved in co-operation with industry.

There is a natural important involvement of the Pro-Rector of Research in matters of co-operation with industry, as he or she supervises almost 50 research centres, many of them connected to industry.

Another actor is CECAE, the Executive Co-ordination for University Co-operation - which is directly connected to the Rector, and operates in close articulation with the Pro-Rectors, particularly with the Pro-Rector of Extension. Through its University-Enterprise Co-operation Programme, which has the acronym USP-TEC, CECAE provides information, overall support and stimulus to the faculty, and provides a gateway to industry into the university. It also manages some institutional interdisciplinary projects with industry, such as Disque-Tecnologia USP. The total permanent staff involved is 10 (three of them are senior). Currently CECAE has three additional senior adjunct staff members, two of them supported by a Federal Programme of Human Resources for Strategic Areas (known by the acronym RHAE).

Similarly, the Autonomous National University of Mexico (UNAM) had created already in 1983 a specialized internal structure for technology transfer, the Director General's Office for Technology Development, with the main function to provide support to the different organizations of UNAM in promoting the services and technologies generated therein. More specifically, this Office was supposed to act as a clearing house for all internal and external information on opportunities for technology transfer, contracts, covenants and agreements on technology development and transfer as well as matters related to patents and other industrial property instruments. Also, this Office was involved in the development of training programmes on technology policy, economics, administration and transfer. Later on, in 1985, the university decided to transform the General Director's Office into a centre to promote innovation management and to facilitate the co-ordination of interdisciplinary efforts. The specificity of this centre is its twofold mission: to act as an academic institution committed to research and teaching related to technology innovation and transfer while, at the same time, stimulating co-operation with the productive organizations.

Box 2. The Centre for Technological Innovation at UNAM, Mexico

Within the framework of the general objectives established in the Agreement for its creation, the following functions were defined as substantive for the Centre for Technological Innovation:

- To conduct research into the technology innovation process.
- To participate in and give advice on the training of human resources in the different aspects of the process.
- To stimulate the forming of links between the technological capacities of UNAM and the productive sector.
- To identify and interrelate multidisciplinary technological projects of priority interest for the country and propose that the competent university authorities co-ordinate actions.
- To provide services to UNAM and other institutions related to planning, management and organization of technology research.
- To help the university authorities with industrial property and suggest university policies governing academic assessment of the technology innovation work.
- To express opinions, within the field of technology innovation and development, on the contracts and agreements signed by the university and the productive sector.

Although, since the beginning, it was defined that the CIT should be organized by projects, each of which would be headed by a specific responsible person, it was in fact organized in three operating units (the Academic, the Technology Transfer and the Evaluation and Control units) and an Administrative Secretariat.

The research and training functions are executed within the Academic Unit, while the technology transfer, industrial property and liaison functions are the responsibility of the Technology Transfer Unit. The Evaluation and Control Unit takes care of the monitoring function, as well as some other supporting functions such as economic analyses and physical infrastructure. The technology transfer staff hold a weekly meeting where some specifics of the current programme are discussed and decisions are made if required. This helps exchange information relating to the cases under consideration and assures utilization of colleagues' experience as an input to solve one's own problems.

It was decided that the proposed centre should carry out its functions in a decentralized way: technology transfer functions should support

the actions of the other sections of the university and those of research into innovation should be developed in close contact with first-degree and postgraduate teaching – a task difficult to fulfil in an organization like UNAM characterized by the great dispersion of its activities and decision-making organs.

A different type of internal interface was created in 1983 by the Birla Institute of Technology and Science, the Technology Innovation Centre (TIC). The function of TIC is to provide space for scientists from industry to investigate a specific problem on the BITS campus through an involvement with BITS faculty and students. The TIC scheme is essentially devoted to facilitate the mobility of scientific staff from industry to the academic campus of BITS and to create a supplementary occasion to students and staff to collaborate with industry on a specific work-related problem.

Box 3. The Technology Innovation Centre of BITS

Technology Innovation Centre has been conceived to be a complementary activity where the problem of industry can be investigated on the campus through the involvement of people from industry, BITS faculty and BITS students.

The main features of this Centre are :

a) The engineer/scientist of the industry would be able to spend the desired period of time on the campus under an umbrella of facilities where time-bound mission-oriented investigations can be made on problems brought from industry by the engineer/scientist himself or by a willing team formation between the engineer, BITS students and/or faculty. Suitable housing and office space would be provided. Further, the engineer/scientist would be accorded an Adjunct Faculty status so that he has access, like any other BITS faculty, to BITS equipment and other infrastructural facilities.

b) Industries floated by engineer-entrepreneurs on a small scale basis would find this umbrella facility to be highly attractive. Usually such industries are more intensely involved in technology absorption and diffusion and occasionally find that they are heavily handicapped by a lack of certain experimental facilities and subcritical mass of a peer group involvement.

c) Industries which are more massive and more preoccupied with the task of operating a technology package for maximum production, would discover many problems which are more easily handled in a campus situation.

d) The projects investigated would not be similar to sponsored research. The investigation will be through the direct involvement of engineer from industry in temporary residence on the campus.

e) The attractive concurrent possibility of linking such industries in the chain of off-campus BITS activities is obvious.

The TIC scheme was started in 1983 with one industry and since then it has been growing. The number of projects offered to students has gone up to 40 in a semester and the number of participating organisations at a time has increased to five. The number of companies that have participated in the scheme so far is ten.

In the process of operation of the TIC scheme over the last few years, many new related facilities have been introduced in the institute. New equipment has been purchased by the institute and the 'TIC companies' have also placed their equipment in the institute free of cost in order to facilitate investigations. Many projects taken up and completed by students have already been introduced at the production level.

The dean of the Educational Development Division at BITS is the overall in charge of the Centre. He is assisted by a team of faculty members drawn from the disciplines to which the project area belongs. The team invites the industry, chooses the projects, selects students, monitors the progress, evaluates the students and keeps time-to-time interaction with experts from the industry.

The Ecole Supérieure de Technologie (ESTC) of Casablanca, a small and young tertiary education establishment in Morocco, has created, within its central administration, a new service, staffed with two persons in charge of developing relations with enterprises. The main functions of this office are to identify internship placements for students, to perform a clearing-house function for job seekers and job offers and to follow-up on graduates.

The Technical University of Lodz (TUL) mentions that there are two high-ranking administrative functions concerned with the management of university-industry relations: a Vice-Rector for Science and Technology with his Science Department, and a Vice-Rector for Promotion of International Co-operation with his Foreign Affairs Department. The functions of public relations and marketing at central level are performed by the Press Agent and a Patent Agent. At TUL, there is also a Central Office for Continuing Education located in the Department of Education under the authority of the Vice-Rector for Student and Teaching Affairs. However, due to the high level of decentralization prevailing at TUL, these structures play only a co-ordinating, supervising, accounting and reporting role, as well as representation of the university in relations with public authorities.

The above-mentioned account of internal interfaces demonstrates first of all the importance given to the development of university-industry linkages in the case institutions. Second, it illustrates the great variety of functions, organizational structures and staffing arrangements for the management of relations with industry. Among the different organizational arrangements presented, the Centre for Technological Innovation of UNAM, Mexico, is particularly interesting. This centre represents an attempt to establish a knowledge base with academic credibility in the domain of technology transfer whose function is to support ongoing activities from an administrative point of view, but also to contribute to cultural change through the provision of in-house training. Most other interfaces, for instance CECAE at the University of Sao Paulo, have a more explicit function to commercialize university products such as CPD, consultancies or R&D. Some institutions tend to centralize different support functions in one structure, whereas others have charged a number of independent entities with different functions such as policy-making, information and public relations, negotiation and contract support, and intellectual property issues. In the latter case, there is definite need to provide overall co-ordination of such activities, as it is usually assured by a high level academic specifically in charge of the development of university-industry linkages.

2. Functions and organizational structures of external interfaces

In addition to internal interface structures, many universities worldwide go a step further and create external interfaces. These external support structures are subject to rules that are less stringent, especially for recruiting and remunerating project staff, as well as in the area of financial management. Their function may vary from case to case. It may be close to that performed by an internal structure, i.e., provide an administrative and consultative interface between the university and industry, or it may be directly involved in the implementation of contract work, for instance in the area of technology transfer, or aim at commercializing university products. However, external interfaces differ from internal ones in that they have a separate legal status from the mother university. Usually such external structures have been set up because higher education institutions have proved not to be flexible and responsive enough, in the light of the highly specialized and interdisciplinary approach required generally by industrial partners, and their administrative rules too rigid. Over and above this, a university-owned company will present a professional face to the outside world, endowing an enhanced status that allows it to negotiate at prices that the market will stand rather than being expected to provide cheap educational services.

Also interfaces, if they transfer their surpluses back to the *Alma Mater*, often benefit from the same charitable status, on similar lines as the institutions to which they are attached. Depending on their legal status (profit making or not), they may benefit from tax exemption on their profits and they avoid corporation tax.

The above-mentioned list of interfaces demonstrates that nearly all case study institutions have set up one or several external interface structures. Examples are the ***University-Industry Research Centres*** of the Faculty of Engineering, Cairo University, the ***Engineering Institute*** of the University of the West Indies, ***university commercial enterprises*** (Yissum at Hebrew University of Jerusalem, UDC at Technological University of Papua New Guinea), ***Consultancy Centres*** (TECO at Makerere University), ***Foundations*** (University of São Paulo, BUVAK at Bogaciçi University), ***Incubators and Science Parks*** (Suranaree University of Technology, BIC at Bogaziçi University, University of São Paulo, Hebrew University of Jerusalem, Lodz Technical University, The University of the West Indies). Despite their different functions presented above, they also differ very much with regard to the degree of decentralization (i.e. attachment to the central administration or to the faculties, departments) which is in accordance with the general culture prevailing at the institution and, of course, with the size of the institution. It is certain that the bigger an institution, the more likely it will set up decentralized structures for management of university-industry linkages.

Three of the eleven institutions which were studied have set up a centralized interface structure for the commercialization of the products of all faculties. For instance, Yissum, a fully owned subsidiary of the Hebrew University of Jerusalem, fulfils the same purpose of interfacing for all faculties of the university with regard to a wide range of functions, including marketing, negotiating, licensing, contracting and creating joint ventures with businesses for creating technology start-up firms.

Box 4. Yissum of the Hebrew University of Jerusalem, Israel

'Yissum' was established by the Hebrew University in 1964. The main objective of the university in establishing this company was to create an effective independent vehicle that would foster and promote university-industry co-operation and relations.

The concept was to create a business-like tool that would develop capabilities in the areas of marketing, negotiations, licensing, contracting and the like. During the years since its establishment 'Yissum' has become a business company with strong abilities in the areas of patenting, intellectual property, licensing, negotiation, and entrepreneurship. Yissum today is a leading firm in Israel, well known worldwide as a business arm of the university to conduct and to foster co-operation with industry and with investors, including in venture capital funds.

Yissum deals with inventions produced by Hebrew University research. It registers patents and their utilization. Yissum represents the Hebrew University in all matters relating to commercial and industrial utilization of the results of the research conducted therein.

Yissum is empowered by the university, *inter alia*, to determine whether the university has rights in an invention of an employee; to decide whether to seek protection for the invention, including prosecuting in the name of the university, with the approval of the management of the university; to define the lines of action and the type of engagement regarding the commercial and industrial utilization of the patents and inventions, and to negotiate with commercial and industrial institutions or bodies and enter into any agreement in connection therewith; to manage and organize the rendering of services on a commercial basis; the commercial and industrial production and utilization of patents and inventions carried out within the university, for it or in connection with it; to define the rules regarding secrecy, including the conditioning of its action for the protection and the commercialization of the patents and inventions by restricting the publication of the inventions in writing or speaking.

Papua New Guinea University of Technology has also set up a central interface, called UNITECH DEVELOPMENT AND CONSULTANCY PTY LTD (UDC). The function of this interface is to commercialize a wide range of products and services offered by the university. It differs however from YISSUM in that it provides a common umbrella interface for independent subsidiaries set up by different academic departments of PNGUT as part of this central interface.

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Box 5. UNITECH DEVELOPMENT AND CONSULTANCY at PNG University of Technology, Papua New Guinea

Unitech Development and Consultancy Pty (UDC) is the principal private company and corporate arm of the University of Technology. Its origin followed initial approval by the Council of the University of Technology in 1987 but actual operations began after formally being incorporated as a company in March 1992. It is registered under the PNG Company's Act and limited by shares.

The mission of UDC is to offer the best professional expertise, research and technical services to government institutions, commerce, industry and the community. Through the direct link with the University of Technology as a pre-eminent technological institution in Papua New Guinea and the South Pacific region, UDC is able to offer a much wider range of renowned expertise on consultancy services, usually at cost-effective and highly competitive rates. In reality, all disciplines through which the university offers academic teaching and researches subject to availability of spare man/hours, can be drawn as consultancy services.

Subsidiary units of the company include UDC Architects Pty Ltd, Audio Visual Unit, Civil Engineering Commercial Unit, Electronic Services Unit, UniTech Guesthouse, Rainforest Habitat, Management Development Centre, Mechanical Engineering Workshop, National Analysis Laboratory and Veterinary Clinic.

Apart from the UDC commercial units, university departments and individual staff provide consultancy and short courses (continuing education) to industry and the community as a whole.

Another case institution of the research project which has adopted a similarly centralized, although apparently somewhat less co-ordinated, approach is Bogaziçi University, Turkey. This university had created as early as 1978 a foundation, called BUVAK. For quite a number of years, this foundation remained relatively inactive with regard to fundraising activities, or in acting as an organizational vehicle for relations with the private sector. Around 1993, it gained tax-exempt status, meaning that any donation made to the foundation would be tax deductible. An interesting feature of BUVAK is that it has established its own companies, one of which is called KAMPUS, for conducting continuing education and consultancy activities. BUVAK itself organizes continuing professional education activities, called the BU Foundation certificate programmes.

All other case institutions have created a number of decentralized interfaces for the management of their relations with industry, which are controlled by the academic units of the institution. A highly decentralized approach is presented by the University of São Paulo, which, as most major research universities, has a highly devolved culture. At USP, each of the academic units establishes its own interface structures - offices, research and extension centres, foundations, etc. The current external interface structures present at USP are the foundations. The first foundation was created in 1967; today there are 24. A particular case is the Foundation of the University of São Paulo (FUSP), which is not connected to any school or department, but to the University Council, which is the highest board of USP. Therefore, FUSP operates as a central, albeit optional, external interface structure under private law. FUSP is open to projects in every area, as long as there is an entrepreneurial faculty member who has been able to attract a project and is willing to manage it technically. FUSP is in charge of the financial management of the project.

Box 6. Foundations at the University of São Paulo, Brazil

The creation of foundations resulted from a grass-roots movement of some faculty, in a certain department or school, in order to facilitate its relations with the relevant external milieu. The foundations were formally established as a private non-profit entity by the Curator of Foundations of the State of São Paulo. Each year a detailed balance of activities and finances has to be provided to the Curator. The foundations sign a long-term co-operation agreement with USP at large; the interested department or school appears in the agreement as an intervening body; a certain amount of its income is forwarded to the university's funds to support research and extension.

The main reason to create a foundation arose from the interest in getting flexibility in the day-to-day operation, in order to cope with expectations of industry and other potential clients. Particularly, there was a perceived need to overcome the limitations to the management of financial resources, imposed by law on USP as a public institution. For example, if a project contracted by industry requires 15 PCs to be purchased, a foundation can act in the market as any private organization, and the best combination of quality, price and delivery time will determine the solution. As financial resources are easily managed, the equipment might be available for the project team in a couple of days. The same need would take several weeks, or even months, to be fulfilled through the highly regulated public bidding procedure that the university has to follow; most suppliers would mark up their prices, some would not offer their products, as they prefer not to deal with public clients; and, one or two might even create obstacles in the bidding process entering court because of some subtle interpretation of the terms of reference.

The foundations allow a significant supplement to the faculty salary that is actively involved, and provides space in projects for graduate students.

The foundations might have their headquarters outside the campus, usually in the immediate neighbourhood; however, most of the activities - courses, projects, etc. - happen on campus, usually against a fee for the use of the university premises.

The department benefits from the foundation investments - e.g. rooms refurbished for evening continuing-education programmes are used during the day for graduate courses. The foundation provides discretionary funds to the department or school to which it is connected, and also to the university at large, which helps to overcome budget constraints.

There is no attempt to co-ordinate the multiple activities conducted by the different units of USP. In practical terms, a researcher has usually up to four options to manage a project: *(a)* directly, as an individual; *(b)* through the university, *(c)* through the 'local' foundation, if there is one in his or her department or school/institute; *(d)* through FUSP. The decision is made by the researcher according to his/her preference, but is strongly influenced by the boundaries provided by the client/partner and by the sponsoring/financing agency.

An equally decentralized approach to the management of relations with the socio-economic environment is prevailing at the University of the West Indies. Such a decentralized approach seems to be natural in the case of a multi-campus university distributed over three different locations. The above-mentioned account of ongoing activities conducted by the University of the West Indies in the domain of relations with the socio-economic environment demonstrates the multiple activities and specialized structures which have been set up as grass-root activities. The particular feature of the Engineering Institute created by the Faculty of Engineering for the organization of continuous education for practising professionals and para-professionals, as well as technological services, is that it provides an administrative umbrella, similar to UDC of the PNGUT, for the subsidiaries set up by academic departments.

Box 7. The Engineering Institute at the Faculty of Engineering, University of the West Indies, Trinidad and Tobago

The Engineering Institute (for the Caribbean) within the Faculty of Engineering, was established in April 1994. In addition to the obvious benefits to the development of the society that would accrue from a greater relationship between the faculty and the industrial sector, and the need to project a positive image in the society at large, income generation has become a declared policy objective laid down in the university's Development Plan 1990-2000. Since the Faculty of Engineering possesses the greatest depth of engineering and related expertise in the English-speaking Caribbean, with a broad range of laboratories containing some sophisticated testing and basic research equipment with personnel support, the resources of the faculty could and should be harnessed towards income generation.

Objectives of the Institute:

- Provide for the formal linkage between the faculty and the industrial and engineering services sectors, and other organizations.
- Provide a range of continuing engineering education services to meet the needs of the Caribbean.

- Provide a broad range of technological services as appropriate to the expertise and facilities available in the faculty.
- Work with the industrial community, international agencies, other departments of UWI and relevant faculties in other universities, on joint projects.
- Co-ordinate and develop the income-generation capability of the faculty.
- Provide a mechanism for substantially increasing academic staff and student interaction with the industrial community.
- Project and publicize the work of the faculty throughout the Caribbean.

Specialized centres are the focus for work carried out in selected areas, whether in continuing education, consulting , testing or research. The institute comprises a limited number of centres and a co-ordinating institute office. The centres identified so far are:

- Advanced Manufacturing and Engineering Centre;
- Centre for Energy Studies;
- Centre for Entrepreneurship and Innovation;
- Centre for Environmental Studies;
- Centre for Food Technology;
- Centre for Geospatial Studies;
- Centre for Hydrocarbon Studies;
- Computer-aided Engineering and Design Centre;
- Continuing Engineering Education Centre.

Another decentralized model of interface established at the faculty level has been reported by Makerere University, Uganda. At this university, the members of the Faculty of Technology have established their own commercial consultancy firm under the name of Technology Consults Limited (TECO). They realized that, while many of them were practising individually off campus, they would make a more effective group if they combined the wide range of competences and expertise under one umbrella firm.

Box 8. TECO at the Faculty of Technology at Makerere University, Uganda

The objectives of TECO are:

- To develop the professional status of the academic staff;
- To extend technical specialist services to the community by solving practical problems in local industries;
- To generate extra income for faculty programmes and staff members.

TECO services cover the following range of options:

- Technical services in electrical, mechanical and civil engineering;
- Technological development services;
- Professional development training services;
- Workshop services;
- Architectural services;
- Surveying services;
- Any other pertinent projects from industries.

In carrying out the activities of TECO, staff members and personnel from industries have worked together on a number of industry-based projects.

From industry's perspective, they have a contact point where specialized facilities and specialist members of staff can be found. Also, TECO has a commitment to deliver on time and at lower cost. It has been found that TECO always bids lower then other commercially oriented firms.

The most decentralized form of external interfaces among the case studies can be reported from the Faculty of Engineering at Cairo University. Within this faculty, several quite autonomous research centres have been created over the years, the first in 1974, to provide technical services to industry. In the decade that followed, specialized centres were established to address quite diverse industrial needs. With the increased number of centres, they became more specific and diversified to cope with equally specific and diversified demands from industry. The case study mentions that three laboratories became full business centres and that there are now nine specialized centres to cover almost every engineering speciality.

3. Governance, autonomy and control of interfaces

As outlined above, the setting up of interfaces, both internal and external, corresponds to the acknowledgement of a certain density of informal relations with industry and marks a policy objective to institutionalize and foster such relations. The creation of external interfaces, be it foundations or consultancy centres, is in response to the need of managerial flexibility necessary to tackle market opportunities and to generate extra-budgetary resources. This implies appropriate marketing of university products and services, capacity to negotiate contracts and decide on the spot whether a contract is worth while from a professional and financial point of view. Administrative autonomy is also necessary for the implementation of a project. For instance, the capacity to purchase a crucial item quickly may be an important asset for an industrial project with a, usually, tight time-frame.

Managerial flexibility implies a considerable amount of administrative autonomy handed over from the *Alma Mater* to the interface, in particular with regard to financial and staff management. Over time, this degree of independence tends to grow and the control over subsidiaries tends to diminish. The subsidiary then sometimes takes too high a profile, which turns then out to be a problem. As a consequence, one of the crucial issues in the successful co-existence of external interfaces and their mother institution, relates to finding appropriate mechanisms of control over policies and daily operations, a system of permanent checks and balances in the relation with the subsidiary and, last but not least, a mechanism that reverts benefits back to the mother organization. In most cases, such formal mechanisms are laid down in the statutes of the interface or in administrative regulations.

Another important dimension in the relation of universities with their interfaces are the communication channels that exist between the interface and the academic units who are the providers of the services offered by the interface. Usually in the beginning, academics do not like to hand over control of their projects with the private sector to an interface. This increases, they fear, the amount of administration in project management and they fear losing control. As a consequence, the interface has to demonstrate its effectiveness and professionalism with regard to the management support it can provide to projects. In other words, it has to relieve academics from what they perceive unpleasant administrative work and let them focus on the professional job. If an external interface does not perform this function, it might face the danger of being bypassed by the academic community. However, there might also be a danger involved if such an external interface adopts too high a profile and when it becomes too independent. In this case, it is the *Alma Mater* that might fear to lose control. As a consequence, it is important that the interface refers consistently to the mother institution as the project owner and supplier of knowledge.

Often, in the initial stage of establishing an interface, communication channels are of an informal nature, meaning that leading staff of the interface occupy or have occupied earlier on management responsibilities in the academic unit. As a consequence, there is then a tight flow of information and communication. A formal organization of such communication channels can be the reproduction of the departmental structure of a faculty into the interface itself, such as we have seen above in the case of Papua New Guinea University of Technology and the Engineering Institute of the Faculty of Engineering, University of the West Indies. In these cases academic departments have created their own commercial units within the interface which are functioning under the umbrella of joint support structures, such as marketing and accounting services. Under this arrangement, academic units still perform major direct control over their business unit. They thus maintain ownership over their commercial units, which is a crucial motivational factor to develop relations with the private sector. The disadvantage of such a federalized approach of a business unit, is that it remains difficult to develop and enact university-wide policies, rules and procedures for the collaboration with the private sector. Secondly, there is less scope for real interdisciplinary project work under a federalized than under a unitary structure.

In terms of governance structures, a lean and efficient organization of the interface is very important. Most interfaces described in the case studies have a similar organizational set-up. They are headed by a collective governing body, i.e. a board of directors, governing board or board of trustees. In many cases, this collective governing body comprises the head of institution or the Dean of faculty, a representative from the private sector and the senior management team of the interface. In order to facilitate information flow and compatibility of procedures, the head of administration of the higher education institution acts as the head of administration of the subsidiary and the university's head of finance, or a nominee, attends the board meetings. In most cases, the university authorities have a controlling vote in the management and general meetings of the interface. Such a set-up guarantees that the *Alma Mater* maintains control over its interface in terms of policies and modes of operation.

A professional management of an external interface is one of the crucial success factors in this domain. For the daily management of the interface, there generally exists a managing director, sometimes supported by an administrative director. According to the functions performed by the interface, there may be several sub-units or departments with qualified personnel dealing with marketing, accounting, managing contracts, and, if applicable, intellectual property, licensing arrangements and so forth. In many cases, interfaces operate their own invoicing and purchasing system. Thus, the interface has the freedom to use bulk purchasing arrangements negotiated with the suppliers. This autonomy is very important when it is necessary to get crucial items delivered quickly.

In terms of financial autonomy, most external interfaces are separately audited, both internally and externally, and its administrative procedures are designed to be fully compatible with those used by the *Alma Mater*.

The centralized and highly professional approach of managing its relations with industry adopted by the Hebrew University of Jerusalem, is reflected in the way the university has set up its relations with Yissum. Rights and obligations of Yissum have been laid down in the university management regulations and there has been an agency agreement between the university and Yissum. Within this well-determined framework, Yissum benefits from the necessary autonomy to conduct its activities with as much administrative flexibility as possible.

Box 9. Autonomy and control of Yissum by the Hebrew University of Jerusalem, Israel

As a company, Yissum retains full autonomy in accordance with the university management regulations relating to Yissum and to university-industry relations in general, and under the agency agreement signed between the university and Yissum, which defined the services that Yissum is entitled to render to the university.

The chairperson of the Board of Directors of Yissum reports periodically to the General Council of the company, at its shareholders meeting, i.e. the university. Periodical reports are provided to the management of the university by the company's Board. Neither the management of the university nor any university officer may intervene within Yissum's activities, discussions and business-making process or corporate policy.

Once the long-term agency agreement between Yissum and the university was signed and once the management regulations of the university were defined, Yissum was fully autonomous and authorized to conduct the contacts between university and industry on the optimal level, and was expected to generate income and to show profits.

The researchers of the Hebrew University are the employees of the university and not of Yissum. When Yissum uses their services, they are paid a consultancy fee by Yissum.

As a policy, Yissum will not hire any researchers to be its employees. All personnel for a specific co-operative project between university and industry will be hired by the university and all research work will be done in the university, while Yissum will ensure that the budget is provided as defined in the agreement between Yissum and the industrial party.

The attitude of the academic community towards Yissum has changed over the years. It was found that as Yissum became more professional and more business oriented, the academic community had more respect for it and accepted its role. Yissum works very closely with the researcher and works very intensively to gain his/her confidence. For the academic community, Yissum is a service agency to foster business-type co-operation with industry.

A somewhat different, more bottom-heavy organizational structure has been adopted by Unitech Development & Consultancy Pty Ltd of the Papua New Guinea University of Technology. Much the same as Yissum, UDC is governed by a board of directors, of which membership is drawn from the University Council. UDC Board directives are implemented through the company via an Executive manager. But subsidiary commercial units such as UDC Architects Pty Ltd, Audio Visual Unit, Civil Engineering Commercial Unit, Electronic Services Unit, Unitech Guesthouse, etc. form the basic units of UDC. A full-time accountant and administrative support staff provide overall managerial service to all subsidiary units. Also, all financial control and corporate affairs are managed by the main office under the Executive manager. Papua New Guinea University of Technology is the sole beneficiary of profits and in-kind support that UDC generates through its operations. The university provides some office space and limited funded research positions on a diminishing scale. UDC has been financially self-supporting for the last seven years of service.

The Engineering Institute of the University of the West Indies (UWI) is attached to the Faculty of Engineering. It has adopted a similar bottom-heavy management arrangement with a board of directors, appointed by the Principal of the St Augustine Campus of UWI.

Box 10. Organizational structure of the Engineering Institute, UWI, Trinidad and Tobago

The board of directors of the Engineering Institute comprises: a Chairman, the Dean of Faculty of Engineering, four other members from the Faculty of Engineering, two nominees of the Principal of the campus, the Chairman of the National Institute of Higher Education, Research, Science and Technology and eight industry members. The first chairman has an extensive public service and industrial background and is at present a senior lecturer in the Faculty of Engineering. Industry members are CEOs from a variety of industries, including public utilities. The four faculty members are leaders of designated centres.

The Institute has a co-ordinating office whose function is to provide the formal interface with the industrial sector in addition to providing administrative and accounting services in the execution of their work. This allows research and teaching staff to focus on executing their contractual obligations satisfactorily and in a timely manner. The Institute office has a staff of three – the manager, a secretary and an accounts clerk-cum-office assistant. Part-time accounting services are provided by the chief storekeeper of the Faculty of Engineering. Other permanent staff of the institute are four persons from the Continuing Engineering Education Centre.

The co-ordinating office handles research/consulting and testing service requests for the faculty which do not fall into any of the identified centres. These centres are operationally peer groups with the Institute office providing the co-ordinating facilities.

The institute is responsible for keeping its own accounts, receiving and disbursing funds and managing all aspects of contracts and project activities. However, the university bursar still maintains a certain amount of control. Outgoing cheques above equivalent of US$1,600 have to be vetted by the bursar, the imprest of the institute's expenditure account is replenished by the bursar on request of the institute, and monthly reconciliation of accounts must be done by the institute. Investment decisions also have to be approved by the bursary.

The highly decentralized, but also academic function of the Centre for Technological Innovation at UNAM is reflected in its governance structures. Indeed, CIT is placed under the authority of the central Research Co-ordination Department and governed by a Committee of academic leaders. With regard to the structuring of the communication between CIT and the research units involved in technology transfer, it was decided to set up in each of the basic units a focal point, called *technology innovation nucleus*, trained by CIT and in charge of disseminating the Centre's expertise in their unit.

Box 11. Governance and internal communication at the CIT, UNAM, Mexico

CIT is attached to the Scientific Research Co-ordination Department. It has a Technical Committee of five directors of schools and faculties and five from institutes and research centres from both the exact and natural sciences and the social sciences fields and an Advisory Board comprised of one representative from the university Board of Trustees, the Administrative General Secretary, the university lawyer, the directors of the university Food, Clinical Research, Energy and Computer Programmes and 10 external advisers appointed by the Rector.

The CIT is a separate division of UNAM with specific functions and responsibilities and, as such, enjoys considerable autonomy. Like all other similar units it is operated by a director and an internal academic council. However, decisions relating to personnel hiring and/or promotion are dependent on the Technical Council for Scientific Research, which incorporates the directors of all other institutes and centres belonging to the Co-ordination for scientific research.

Otherwise, the CIT is totally free to establish co-operation agreements with third parties, as long as the central authorities approve the terms and sign the contracts.

There were numerous requests from the university organizations to negotiate the transfer of their research results. They differed considerably as regards content and potential users, and therefore required different types of specialists in order to properly attend to them.

The creation of nine *technology innovation nuclei* in the organizations themselves was the obvious answer. Each nucleus has an individual responsible for its whole operations. Most of them have been trained at the CIT or by its personnel. In some cases the 'nuclei capabilities' are limited to those relating to users' identification and selection, while the CIT contributes with supplementary capabilities such as economic value determination and bargaining power. The technology innovation nuclei would make it possible for them to have specialized capacity and to orientate CIT as to the provision of support services, such as the identification of enterprises that might be interested, the determination of the economic value of the technology, the negotiation of terms, the orientation of the transfer process, intellectual property protection, the drawing up of contracts, etc.

At the University of São Paulo, foundations are controlled widely through informal mechanisms by the faculties which have created them. Informal mechanisms relate to the predominantly academic membership and the leading function of their governing bodies, in particular the Board of Trustees. Such an academic membership facilitates the communication and co-ordination with the mother institution. However, it is certainly not a factor that helps to overcome the communication gap between the university and the private sector.

Box 12. Governance, autonomy and control of the foundations of the University of São Paulo

Every foundation comes into existence only after its statutes are approved by the Curator of Foundations (a public servant connected to the Judiciary). Thus, there are basic tenets that are common to all foundations, e.g. its governance model. However, the specific statutes and modes of operation are not subject to a common legal framework. The university does not impose specific items in the statutes or modes of operation - each dean deals with the foundation(s) connected to his or her school or institute and acts as the intermediary between the foundation(s) and the central administration of USP. The Rector deals directly only with the *Fundação de Apoio* at the University of São Paulo - FUSP; indeed, he is the President of the Board of Trustees '*ex-officio*'.

All members of the directorship of the foundation and most members of its overseeing council (called by law 'Curator Council') are faculty. They are forbidden to receive any financial recompense for their administrative function, but are allowed to receive payment for their possible participation, as teachers in courses organized by the foundation, or as project staff members.

Foundations are steered by their *Alma Mater* mainly through informal mechanisms. The informal mechanisms are concerned with the social contract among the faculty. For instance, there is a tradition - not a rule

- that the Head of the Department of Industrial Engineering is a member *ex officio* of the Board of Trustees of Fundação Vanzolini (the first foundation connected to USP, created in 1967 by the faculty of the Department mentioned). It has been an informal mechanism to assure social cohesion among the faculty body, some of which do not have any activity with or through the foundation.

The organizational structure of TECO, the consultancy firm attached to the Faculty of Technology at Makerere University, is also headed by a board of directors, which, surprisingly, does not include any representatives from the private sector. Since TECO is a staff-owned subsidiary, the board of directors has naturally a predominant academic composition. Its organizational set-up resembles the Engineering Institute in that it gives academic departments a strong stance, since all division heads (heads of department) sit on the board of directors and head project units such as civil engineering, electrical engineering, mechanical engineering, surveying services, architecture and building services, and technical and feasibility studies.

Box 13. Organizational structure of TECO, Faculty of Engineering at Makerere University, Uganda

TECO was formed as a private limited-liability company with members of the faculty staff in 1992. TECO policy is established by a board of directors currently composed of the following:

Chairman : Dean of the Faculty of Technology
6 members : Heads of departments/division
1 member : Financial director/Business manager
1 member : External Director
1 member : Secretary to the Board
1 member : Assistant business manager.

TECO draws on expertise from about 25in-house consultants who cover most areas of the various technical disciplines. However, where in-house capabilities are not available, TECO works with other consultants and consulting firms on specific projects. Collaboration with outside consultants and firms also helps TECO build capacity and experience in areas where there might be insufficient expertise. Day-to-day running of TECO is under a business manager/financial controller who is assisted by an assistant business manager. Other support staff includes the accounts clerk, a secretary, one draughtsperson and a messenger.

Consultants (staff members) are not full-time employees of TECO. They have no retainer salary from TECO, but they are paid a fee on each completed project they participate in.

A somewhat different type of interface is the Uganda Gatsby Trust (UGT), a non-governmental organization attached to the Faculty of Technology of the University of Makerere. Its function is to provide an interface for local-enterprise development, especially that of the SME sector. It acts through the development of a network of micro-enterprises linked to the Faculty of Technology, many of which are located in the informal sector. Collaboration of the informal sector with the Faculty of Technology provides major opportunities for sustainable, local economic development. The Uganda Gatsby Trust provides integrated services of enterprise consultancies, technology transfer, staff exchange, staff development of the enterprises and a scheme of loans to enterprises through the creation of a co-operative bank. Exchange of peer experience among local enterprises is assured through the creation of so-called regional branches of UGT.

Box 14. Governance and organizational structures of the Uganda Gatsby Trust, Makerere University, Uganda

The Uganda Gatsby Trust is governed by a Board of Trustees selected to reflect the representation of the stakeholders in the small-scale sector. The Trust is administered internally by a Project Co-ordinator (General Manager) who is assisted by two Assistant Project Co-ordinators for Extension and Innovation. At the moment, the above three individuals are lecturers in the faculty. The main resource persons for this scheme are the highly skilled faculty staff and some co-opted consultants from other faculties, specially that of Commerce, or in town as the need arises.

The Uganda Gatsby Trust is continuing to set up Clubs in selected towns to enable constant contact and interaction between UGT member small enterprises for greater impact. Specifically the Clubs are set up to:

- Establish core membership of UGT to operate with and ensure demand-driven services.
- Establish an institutional framework in target areas for continued UGT support to improve impact.
- Enhance savings and credit schemes through group membership and peer-group pressure.
- Raise funds for UGT through membership subscriptions to the UGT Clubs.

Each Club is managed by an elected Executive Committee comprising of: a chairperson, vice-chairperson, secretary, treasurer, committee members.

Sometimes a representative of the Co-operative Bank and UGT Headquarters can attend the Executive Committee meetings. The members of the committee serve on a voluntary basis and are responsible for:

- organizing all branch activities such as seminars, training courses, etc., with UGT providing the funding and resource personnel;
- liaising with local authorities and Co-operative Bank branches;
- organizing club members into groups for purposes of them borrowing and cross-guaranteeing each other for the loans while establishing peer pressure;
- running a savings scheme in which all members contribute and save funds for emergency lending to the members;
- liaising constantly with the UGT office at the Faculty of Technology, Makerere University, Kampala;
- managing the operation of the local showrooms, which are used as avenues for marketing of members' products.

At present, financial management and control of Uganda Gatsby Trust is vested in the Board of Trustees and the Project Co-ordinator. Two Board members, one of whom is its Chairperson, together with the Project Co-ordinator, are the signatories to all the financial transactions of the Trust. The Trust is audited annually to the satisfaction of all Board members and other stakeholders.

The above-mentioned case examples demonstrate that the management structures of interfaces show an important number of similarities. They are generally overseen by a governing board or a board of trustees, which is most often composed, at least partially, of high-level administrators and leading academics of the mother institution. Some governing bodies, however, also comprise representatives from the productive sector or the regional authorities. The statutory composition of the governing body, and in particular the weight given to academics and external professionals, represents indeed a trade-off between a desire for control over policy and activities of the interface, expressed by the academic community, and a better outreach to external actors, which is better ensured if outside stakeholders are directly involved in the governance of an interface. The statutory composition of the governing body of an interface reflects the priority given to one or the other objective and, of course, the specific power relation prevailing in an institution at a given point in time.

The control of and communication with interfaces can be ensured through formalized agreements, such as in the case of Yissum, where relations are structured through the university management regulations and in a special agreement drawn up between the university and Yissum. Such formalized agreements specify the governance and organizational structure of the interface, its specific function and tasks, regular reporting requirements to the *Alma Mater* and the specific degree of autonomy in administrative and financial matters. However, most frequently, academics try to control the interface through their representation in the governing bodies of the interface. According to the organizational culture of the mother institution, there may be informal rules with regard to the management functions to be occupied by a leading academic to manage the interface.

If external interfaces are generally controlled, formally or informally, by the academic management, they benefit most frequently from a professional management with an executive director, who is generally a professional manager with some experience in academia. The separation between academic control and professional management is currently perceived as one of the success factors in the management of external interfaces, since it is one of the mechanisms through which control can be combined with necessary administrative autonomy.

The organizational structure of interfaces reflects usually the functions to be performed or the services offered by the interface. This account of the organizational structures of interfaces has shown that there are central and decentralized interfaces, the latter belonging to some basic unit (faculty of department of the university). Central or decentralized interfaces are a matter of the complexity, degree of decentralization, internal distribution of authority and organizational culture prevailing within the mother institution itself. The same can be said for the internal structuring of the interface. The case institutions demonstrate two major options: the interface is organized either by an administrative support function or by units rendering specific professional services. If the latter is the case, it can be assumed that departments want to maintain control over their particular unit within the interface themselves. Such a structure has the advantage of facilitating communication between the interface and the academic departments and of preserving their ownership of projects. It does not, however, facilitate the development of an institutional body of codes and practices for collaboration with industry, nor interdepartmental collaboration leading to interdisciplinarity.

One can conclude that the choice regarding the governance and the organizational structure of the interface seems to be made with regard to two major concerns: the specific functions to be performed by the interface and expected organizational effectiveness, and last, but not least, the predominant culture and specific power relations prevailing in the mother institution.

5. FINANCIAL MANAGEMENT

It has already been pointed out that one of the main reasons why relations between higher education establishments and the socio-economic environment have developed considerably over the past decade worldwide is because these institutions are facing ever-increasing financial constraints and they are looking increasingly for opportunities to generate extra-budgetary income. Several case-study institutions, among which the University of the West Indies and Bogaziçi University, Turkey, have made it an explicit policy objective to supplement their core funding from government through active commercialization of their products and to create thereby a diversified income basket.

But the financial stringency of public core funding is only one reason. The other reason is that institutions and their sub-units increasingly try to create some financial room for manœuvre through income generation, since extra-budgetary funds are generally less committed than governmental core funding. Such generated income is akin to funding departmental or institutional strategies which correspond to locally identified needs and priorities. The generation of income is therefore also a means to create room for manœuvre in the pursuit of institutional strategies and policies and to widen the autonomy margin of an institution.

However, it should be underlined again, that the search for extra-budgetary funds is not the only driving force and that there are many other worthwhile reasons for conducting joint projects, many of which have already been outlined in the introductory section of this report. A collaborative activity with industry can be conducted at a financial loss because it is likely to generate important knowledge or because it helps to establish a profitable relationship in the long run. However, it is necessary that institutions are aware that they are operating at a loss. The financial management aspect of projects of whatever type with the productive sector is thus extremely important to assure a sustainable, mutually beneficial relationship, in particular if it is profit orientated.

Several critical aspects in the financial management of collaborative activities with the productive sector have been investigated through the case-study research. The first relates to the existence of appropriate mechanisms to determine the cost/price of a commercial product or service. The basic assumption is that if such products and services are not financially rewarding, they will not be sustainable in the long term.

The second critical aspect refers to appropriate mechanisms for the distribution of generated income. Here the assumption is that if there are no such appropriate rules and procedures, perceived as fair by the institutional stakeholders, there is most likely no sufficient incentive for staff to accept a supplementary workload, in particular in the long run.

The third critical aspect is the existence of risk capital. Such capital is often not available before a considerable amount of income has been generated and put aside to finance promising joint ventures which are of particular scientific or institutional interest, beyond an immediate market concern. However, many projects need some seed money to be able to take off, in particular if there is no national programme or agency that will provide for some kind of matching grant.

1. Generation of income

Revenues generated through collaboration with the productive sector can be quite substantial. Several types of revenues can be distinguished: first, there are revenues generated through the delivery of products and services which are usually a function of income minus expenditure. Second, there is more and more revenue gained indirectly from royalties and licences through an active policy of marketing intellectual property rights (IPR). The case example of the Hebrew University of Jerusalem (HUJ) demonstrates that considerable revenue can be collected through joint research projects and royalties, if universities pursue an active policy with regard to their IPR. It is interesting to note that HUJ expects these revenues to grow considerably in the years to come.

Box 1. Income generated through collaboration with industry by Yissum, HUJ, Israel

The total turn-over of Yissum for 1998 is US$14 million. All income is collected from industry as the result of university-industry co-operation.

Yissum's operational costs	US$0.8 million
Secured for research budgets	US$9.7 million
Income from royalties	US$3.5 million
	US$14.0 million

The total turn-over has increased from US$10 million five years ago to US$14 million and is expected to reach US $20 million within five years, mainly because of the rapid increase in income from royalties.

As a matter of policy, the university does not provide any funds to Yissum. The subsidiary should be self-supporting and is expected to transfer research funds to the university. Approximately US$9 million is being transferred from Yissum to the university in 1998 as follows:

For research projects	US$6.3 million
For overheads	US$1.5 million
From royalties collected	US$1.2 million
Total	US$9.0 million

It is expected that within five years Yissum will transfer to the university an annual sum of US$15 million.

Bogaziçi University, a leading Turkish university, has also been able to generate quite considerable amounts of income. Since 1992, the direct government contribution has declined. All other sources of income have increased, in particular the income generated through continuous professional development and further education. Income gained from CPD, research and technology transfer, consultancies, so-called miscellaneous income, the revolving fund and the Foundation BUVAK represents 14 per cent of the total university budget. Such income exceeds the income generated through tuition fees which makes up only 9,4 per cent. Details on the activities and amounts that have been collected in 1997 are given below:

Box 2. Income generation at Bogaziçi University, Turkey

In 1997, Bogaziçi University has been able to generate the following sources (in c.million US$ approximately)

Government	20.0
Tuition	3.0
Continuing education	0.5
RTT	0.2
Consultancy	0.5
Miscellaneous income	0.4
Revolving fund	0.5
BUVAK	2.8
Total	31.9

Miscellaneous income includes income from alumni, the summer school, educational courses, donations, miscellaneous fees, rents and interest.

Details with reference to some particular activities as mentioned below:

MESSE Seminars: These are one- to three-day seminars on popular subjects organized by the interface KAMPUS. In 1996, a total of 39 public seminars (income: US$155,000) and 28 in-house seminars (income: US$133,000) were organized.

BU Foundation certificate programmes: These are 6- to 60-day events, the programmes of which are controlled by the academic council. In 1996, only one programme was offered with the title Executive Strategic

Management Programme and it grossed US$152,000.

BU Certificate programmes: These are 6- to 30-day events controlled by one of the academic bodies of the university. The volume of activities in 1996 was US$67,725 gross for Turkish, Russian, and Japanese language programmes.

Courses/seminars on a specific topic: These are events proposed by faculty members as one-time events on a specific topic, lasting usually one-two days. In 1996, the gross income from this type of activity was only US$17,260.

Consultancy: In 1996, the consultancy activities under the general heading of Strategic management and miscellaneous consultancy (9 cases) totaled US$47,670; Technological consultancy (54 cases) totaled US$141,680 and consultancy on Total Quality Management (TQM) totaled US$247,000 for a grand total of US$436,350. However, this figure does not reflect the real volume of consultancy activities, some consultancy goes unreported. Efforts are being made to improve organizational capabilities and to increase faculty sensitivity to transparency to minimize such cases.

Income generation through educational courses offered to companies or the public at large without any educational prerequisites (generating almost US$1.3 million).

The importance of a diversified income basket has been clearly recognized by Bogaziçi University, as well as the fact that the private sector can be the major source of alternative income. The university benefits in this respect from an important comparative advantage over other institutions in Turkey. Bogaçazi University is known to attract the best students of the country and has an excellent academic reputation. As a consequence, the marketization of continuing education is relatively easy.

The Ecole Supérieure de Technologie of Casablanca, Morocco, had equally been able to generate income through continuous professional development. In 1998, this institution collected 315,157.25 dirham (= US$34,405)[4] through such activities. This is of course a relatively small amount, but it needs to be appreciated as being generated by a young and small institution of only some hundred students.

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[4] Exchange rate: US$1 = 9.16 dirham.

TECO, the consultancy firm of the Faculty of Technology at Makerere University, has been able to considerably increase its income from 174,850 UShs in 1992 to 33,765,875 UShs (= US$25,011)[5] in 1997. This allows academic staff to top up their salaries considerably and to avoid further brain drain.

Below is a brief summary of the profits from 1992 to 1997. One can see that there is a steady trend to increase the profit:

Table 3. Evolution of income generated through TECO from 1992 to 1997 at Makerere University, Uganda

Year	1992	1993	1994	1995	1996	1997
Profit Uganda Shs	174,850	1,420,116	5,250,625	9,790,931	17,127,510	33,765,875

The accounts for these profits were generated as follows:

Box 3. Profit and loss account of TECO, Faculty of Technology, Makerere University, Uganda, in 1997

Revenue	**Notes**	**UShs**
Proceeds from services	1 and 16	358,040,210
Less: Contract expenses	3	144,525,969
Consultant fees	4	91,157,872
Direct job costs	5	1,947,650
		237,631,491

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[5] Exchange rate: US$1 = 1,350 UShs.

Net income on contract		120,408,719
Add: Sundry income	2	2,709,000
Gross income		123,117,719
Less: Administration exp.		
University Council		13,494,260
Faculty of Technology		18,892,053
Staff salaries	6	13,104,750
General Office	7	14,909,268
Promotion costs	8	5,953,310
Annual General Meeting	9	1,993,100
Board expenses	10	1,809,050
Finance charges	11	3,650,887
Total operational costs		73,806,678
Profits before tax		49,311,041
Less provision for tax	15	15,545,166
Profits after tax		**33,765,875**

The above-mentioned figures provide some fragmented insights into the importance of revenues that have been generated recently through collaboration with the private sector. Obviously, such figures would need to be appreciated as a proportion of the total budget of the institution to see if they are able to create real margins of autonomy. Here, they are presented for illustrative purposes.

The other case institutions do not provide such detailed accounts of profits and losses, which is often due to the non-availability of aggregated information at the central level, given the decentralized nature of operations. Also, information on generated income might be sensitive, since many institutions fear that government will cut the core funding, if it is aware of the extra-budgetary resources. However, without giving further detail, most of the case institutions report that they have been able to considerably increase their revenues collected from collaboration with the private sector. One example is the University of São Paulo, whose numerous foundations help not only to supplement the government core funding of the institution, but where collaboration with industry helps to generate material resources such as laboratories, buildings, equipment and other materials.

Box 4. Income generation through the Foundations at the University of São Paulo

A sizeable amount of extra-budgetary funds have been generated by the university system through interaction with industry. Some of them come directly from industry, and others are supplied by programmes such as FAPES/PITE and FINEP-TEC. Because of the high degree of decentralization and the large number of external interface structures, resources flow in many ways.

1. The university foundations are legally established as non- profit because of several reasons, among them the fact that this makes them eligible to receive grants from governmental agencies to develop research-type activities, and scholarships. This concept applies also to foundations connected to private universities that chose recently to be for-profit (the university became for-profit, but the attached foundation remains non-profit).
2. This does not mean that: *a)* the foundations connected to USP or to any public university in Brazil generate no surplus (which is legally not a profit, in spite of also representing mathematically a positive amount after one subtracts costs from income); and *b)* they do not provide generous amounts to the 'mother' - be it the university and/ or a school and/or a department. On the contrary: *a)* all of them generate surpluses, in some cases of six digits; and *b)* all of them transfer resources to the university in a direct way (e.g. providing monthly no strings-attached money to a fund managed by the Dean or the Head of the Department, or donating equipment used in projects), or indirectly, paying for items that otherwise would burden the university budget (e.g. a recent case of the USP's School of Business foundations, which put up a five-figure sum in order to finish a major renovation in the main building of the school).

3. In the case of CECAE, it does generate surpluses – for instance, by providing courses on technology issues to people from business – and uses them to fund initiatives which are of interest to the university, thereby supplementing the very small operational amount that it receives from the university budget.

In general, the university benefits frequently from interaction with industry by receiving laboratories, buildings, equipment and material purchased for the project purposes and donated by companies. These facilities and inputs are available for the teaching and research activities, therefore alleviating pressures on the general budget.

The Technological University of Lodz is an exception to the general trend of a growing income from extra-budgetary resources. The university mentions that after the transformation and privatization of industry, the university income from the interaction with industry has fallen from about 50 per cent of the total university budget during the communist period, when industry was obliged to finance research activities, to less than 1 per cent in 1996, when industry started to become widely privatized and has its own serious economic problems linked to transformation. Often new foreign owners of a former Polish company prefer to purchase R&D services from the universities of their home countries.

2. Costing and pricing of services

One of the most crucial success factors in the management of relations with the private sector is the availability of appropriate instruments for the costing of services. The costing of consultancies and continuous professional development is relatively easy, since staff time is one of the main cost items and its estimation is comparatively easy. However, the estimation of the costing of R&D activities currently poses many problems. In most systems of higher education, the budgets linked to commissioned or collaborative research have immensely increased. The concern with appropriate costing tools for collaborative

R&D activities was initiated during the Second World War, when universities in the USA became heavily involved in 'sponsored' scientific research, in particular for the military. In this context, a set of rules, covering cost-sharing for research projects overseen by the USA Office of Management and Budget (OMB), gradually emerged and became, later on, the standard rules for collaborative projects with private funders of research. In most other countries, including the Western European ones, such rules are not well established as of today, and this has often led to heavy financial losses incurred by institutions.

For instance in the United Kingdom, recent studies conducted by the Committee of Vice-Chancellors and Principals and the Higher Education Funding Council have identified a 'funding gap' (i.e. the gap between, on the one hand, their total income for research from the Higher Education Funding Council of England (HEFCE) and from all external research sponsors, and, on the other hand, the full cost of all externally sponsored research) amounting to £440 million in 1995/96. This would be due to the fact that universities have not succeeded in establishing the true indirect cost rate (overhead) with sponsors which, in many instances, is still considered to be negotiable. Also, insufficient attention has been given by institutions to the costing of staff time, often difficult to evaluate in R&D work and often underestimated in project activities.

Institutional costing and pricing policies

When establishing a pricing policy, it is necessary to distinguish various types of collaborative activities which follow different pricing patterns. As mentioned above, there may be many motivations for higher education staff to commit themselves to joint activities with industry. In the R&D domain, such motivations can be geared to having access to state-of-the-art knowledge and industrial equipment, given the fact that in some areas R&D conducted by private research laboratories is ahead of public research. If there is substantial involvement in research of both parties, shared-cost contracts with industry will be negotiated. Such joint activities would be expected to result in scientific and monetary benefits to both partners. The financial contribution of the company will be an agreed percentage of the total costs depending on the distribution of the expected benefits. Usually, such shared-cost contracts do not take into account indirect costs or overhead provisions.

Another type of interaction may be a project establishing a start-up firm for the commercialization of a university patent, for instance initiated by a former university graduate or an academic staff member. As a principle, a university should not compete with its own alumni or its staff, by presenting financial proposals at a bid with subsidized prices. On the contrary, to foster product or process innovation such projects are financially or logistically supported and taken care of within the framework of a Business Incubator or an Innovation Centre managed or subsidized by the HEI.

However, work commissioned by a private company for which there is a contract to deliver certain outputs within an agreed time-frame, should be negotiated at least on a full-cost basis, including the cost of all academic-staff time. Since such research or consultancy has to conform to quality standards available from the market, a net contribution to general income after all costs, including an element for capital depreciation, should be expected.

In the determination of the price of a university product, it is necessary to distinguish two approaches. The first major distinction to be made is that between cost and price. Universities need to have appropriate accounting tools to be able to determine the full cost of a service, whatever the price to be charged will be. It may be decided that the price of a product is below the cost. However, the institution should be aware of this and make an informed choice of accepting an opportunity for collaboration, for reasons other than financial. It should also be aware that such a price below cost needs to be subsidized from other resources.

The most common approach to the costing and pricing of a commercial service is the ***market approach***. Here the reasoning is simple: the price of a service is determined by what the market can bear and prices are negotiated between the supplier and those who demand the service. In general, consultancy fee rates currently in use should be established in accordance with outside market forces, rather than on the basis of cost to the institution. Sometimes, such as in the case of short courses, the price is set by the institution, but prices will be adapted later on according to the interest that one was able to generate for a training activity at a given price.

The other approach for the pricing of products is the *full-cost approach*. The calculation of full costs, for instance for a commercial service, may include the following: all scientific labour time on the project (salaries and all on-costs) of both permanent and contractual personnel, all recurrent costs (travel, consumables, external services, etc.), equipment purchased for the project and depreciated over an appropriate period of time, and overheads (infrastructure such as premises' running-costs or rental and administrative support).

The pricing policy prevailing at the Birla Institute of Technology and Science, Pilani, India, illustrates the diversity of approaches to costing in accordance with the nature and objectives of a given activity. At this privately financed university, emphasis is put on education and training. Even if such collaborative activities are viewed as a means to generate income, they are also considered as a means to share ideas, technologies, as well as human and physical resources. However, university-industry programmes are not subsidized by the core activities.

Box 5. Costing and pricing policy at BITS, India

At BITS, the university-industry linkages programmes are classified into three major activities; each will have different approaches for costing.

These are:

1. Training of its students (both undergraduate and graduate students) by keeping them as interns at the industry sites and engaging them on the ongoing projects relevant to their academic interests - this is called the *Practice School Programme*.
2. Consultancy projects sponsored by the industries, to be done at the campus with the participation of faculty and students - this is called the *Consultancy project/Technology Innovation Centre*.
3. Training of employees of the industries through *off-campus and collaborative distance-learning programmes*.

While all the above are educationally valid and important activities of the university, the method of costing will be different, since each has a different goal, different approach and different level of participation.

Practice school: This activity is essentially initiated by the university for the benefit of practical training of its students and becomes part of the academic programme of the student. Hence its costing becomes part of the on-campus educational cost. However, since these programmes are also faculty supervised, there are additional costs, such as obtaining getting office space for faculty, seminar/conference space/library facilities for students.

Industries normally provide these facilities and thereby meet these costs indirectly.

Consultancy project/Technology Innovation Centre:

When a big industry sponsors a project, it is referred to as a consultancy project, the costing is done by considering all components such as manpower costs (scientific, technical and secretarial), special equipment, travel, stationery, and contingencies. This will be the market price (comprising institutes' overheads for space, utilities such as electricity etc., but projects have to be self-supporting). A simple method is that no special budget allocation is made in the normal university budget for conducting such an activity. Any special equipment, components, consumables etc. required have to be provided by the participating industry. The time required to be spent by any faculty member especially for this project will be charged on a man-hour basis and some overhead for space and electricity may also be charged.

Each situation will be decided on a case-by-case basis. This is done institutionally and a dean heads a division, called the Educational Development Division, who will negotiate this.

When an individual from a small-scale industry, normally a scientist/technocrat entrepreneur, wants to conduct a project, which he himself will supervise, giving it as academic projects for students, and takes the help of faculty as resource persons, the institute takes it as a part of the technology innovation centre. In this case the costing is done in a minimal way – only the direct costs for any special components/glassware/chemicals to be used. No other overheads are charged. This is essentially to encourage innovation.

Off-campus collaborative distance-learning programmes:

This programme is carried out essentially to train employees of participating industries to meet the human resource development needs of the industry. The training programme is converted into an academic degree programme. The entire education will be conducted at the workstation by integrating work and learning. In this case the industries have to pay the prevailing tuition fees of the institute for each of the employees to be trained. Further, the industries should provide, at their cost, classroom/laboratory/computer facilities and also nominate senior officers of the industries to act as mentors for the students.

There is a semester fee pattern for on-campus students. For distance-education students also the same fee is charged. Of course, in the distance learning, the institute's costs for conducting a course will be almost half the cost of the same on campus. However, the distance-education programmes require more in terms of developmental costs. Hence, money so saved will be used for development as well as for subsidies to on-campus education.

Traditionally universities have tended to set out in their cost schedules the individual components of direct costs and add a quoted percentage to cover indirect costs or overheads; this percentage is often open to negotiation with the sponsor. Such an approach should be avoided, since the overhead is a part of the full cost and should not be negotiable.

The prices to be determined should be based on labour rates, i.e. standard hourly or daily rates for each grade or staff which incorporate indirect costs and direct salary and other salary-related staff costs. Institutions should prepare schedules of labour rates for the various categories of staff.

Most institutions studied in this research have established such rates. The rules laid down in the Management and Accounting Policies and Procedures prevailing at UDC at the PNG University of Technology are presented below:

Box 6. Professional fees and rates of UDC at the Papua New Guinea University of Technology

Professional charge-out rates for consultancy work other than short courses can be based on the following:

- By using the current approved fee scale of each professional body as a minimum.
- By using a daily rate of K400 - K600 per day as minimum.
- By using the following minimum hourly rates:

Principal consultant	K75 - K90 per hour
Assistant consultant	K50 - K 65 per hour
Technical officer	K15 - K20 per hour
Technician/draughtsman/lab assistant/ secretary/typist/admin. officer	K8 - K12 per hour
General helper/labourer	K 5 - K8 per hour

Fees for undertaking short coursework will be determined on a case-by-case basis. However, care must be taken to ensure that fees charged are competitive and consistent with other similar courses.

Rates are inclusive of 65 per cent to consultant, 25 per cent to UDC and 10 per cent to department.

Exchange rate (1998) US$1 = 2 kina.

In the case of consultancies, cost may be determined by multiplying the number of days spent on the activity by the labour and overhead rate applicable to other forms of contract, thus ensuring that indirect costs are also recovered. Where the 'day rate' negotiated with the client is above the level, the income yield will be higher than the cost to the institution, the balance being available as a fee to the consultant.

Several case institutions, such as the University of the West Indies or Makerere University, mention that they apply standard rates for consultancies established by professional bodies such as the Association of Professional Engineers of their country. Such an approach helps to avoid lengthy discussions with clients on the basis to be applied for a major cost item.

Box 7. The costing of a training course by Makerere University, Uganda

In the case of training services, the cost covers fees, per diem, factory/enterprise visits, welfare, venue, publicity, transport and documentation.

Below is an average cost for one training course (assume 30 participants for five days and four facilitators).

Item	**Quantity**	**Rate** (Shs)*	**Total** (Shs)*
Fees	5 days	640,000	3,200,000
Per diem	20days	60,000	1,200,000
Factory visits	1	200,000	200,000
Welfare	200 meals	5,000	1,000,000
Publicity	1	300,000	300,000
Documentation			800,000
Transport	500 per km.		

On average the cost is about Shs.260,000 to train one person.
*US$1 = Shs.1,300

Facilitators are paid Shs.160,000 per day (see item on fees).

At present, Uganda is at full speed with the privatization process recommended by the IMF and the World Bank. Consequently, competition is intense. One has to be very careful in keeping the profit margin sufficiently low so as to compete. Further, the quality/skills of workers is not very high, and therefore the products are not of the high grade required by a competitive market.

University consultants have been hesitant to cost up their services/fees appropriately and bring them into line with the outside market. Consequently, costs of goods produced in the university are cheaper than those manufactured outside.

With respect to publicity, university-industry relations are being strengthened especially through student attachment, consultancy, attending trade fairs, seminars, contacting opinion leaders, parliament, ministries, NGOs (both local and international). This approach is slowly yielding results, as more people and organizations are learning about the services and responding quite favourably.

Many institutions have developed costing sheets which must be completed by the responsible staff in charge of project execution. Such costing sheets have to be applicable to a multitude of circumstances. They need to be concise in order not to bother staff with unnecessary administration. The sheet used by UDC of PNG University of Technology for the costing of its consultancies and short courses is presented in Appendix 2. The costing sheet of UDC foresees a handling fee which is a withholding tax provision collected by UDC on reimbursement of claims of goods and services that are either not strictly related to academic training and research, or provided by suppliers without a certificate of compliance.

A question for discussion currently is whether institutions should add to the full costs of a project a profit percentage. There is a view that the introduction of a 'profit' into pricing might conflict with the charitable or non-profit status of public institutions, such as universities. However, it may also be argued that the profit formula gives the university a fair and reasonable return on capital employed, comparable with the average return earned by industry.

Box 8. The profit formula suggested by the British Committee of Vice-Chancellors and Principals

The British Committee of Vice-Chancellors and Principals suggests to apply a profit formula which contains a capital-based and a cost-based profit element. The aim is to convert the percentage return on capital employed to a percentage which can be applied to the contract costs.

As an example, if a university's CP/CE is 2.32 and the historic cost-based rate for risk contracts (those subject to a maximum price) is 4.05 per cent for CP and 10.55 per cent for CE (historical cost basis), then the profit is:

$10.55/2.32+4.05 = 8.60$ per cent on costs.

CE = Capital employed

CP = Cost of production

Source: CVCP. 1998."Costing, pricing and valuing research and other projects". In: ***Report and recommendation to universities***, from http://www.cpcp.ac.uk/pubs/costing.

Calculating overheads

If full costs are to be charged to a contractor, then there must be appropriate guidelines for the calculation of overheads. During the late eighties, the British Committee of Vice-chancellors and Principals recommended that, since academic staff salaries account on average for about 45 per cent of the total expenditure of British universities, the payroll of a collaborative activity should be multiplied by about 2.2 in order for any project to make its proper contribution to institutional costs.

This proposal poses a number of difficulties since it implicitly assumes that the entirety of the central services of a university are necessary for any activity, be it teaching or research. However, organizations in which the principal function is contract research, have different administrative structures and associated costs from those where the prime function is the teaching of students.

In general, the separation of the research costs of a university from the costs of its other activities poses a challenge to traditional accounting procedures. The manner in which buildings, equipment, central facilities such as libraries, etc., are treated, and the assumptions used concerning apportionments of their use for teaching and research purposes, are difficult to evaluate. Also, many older universities are using buildings which have no value, in accounting terms, as they have been fully depreciated, although running and maintenance costs can be legitimately included in an overhead calculation.

In estimating full costs, the indirect costs are normally expressed as a percentage of the major components of the direct costs. Since in most projects labour costs are a substantial element in research, a percentage relationship between indirect costs and labour costs is often appropriate. Where a project is capital intensive, an alternative recovery method should be considered.

There is a current trend to establish a unit cost overhead rate for the university sector as a whole. Such a rate can be established on the basis of all university expenditure. This avoids analyzing the costs of each university department. The unit cost rate could be expressed as a percentage of labour costs (including social charges).

Box 9 provides an example of a method to calculate an overhead which was put forward in 1989 by the Australian Vice-Chancellors Committee and which proposes differential rates of overheads for laboratory-based research (154 per cent of direct labour cost) and non-laboratory-based research (113 per cent of direct labour costs).

Box 9. Calculation of overheads per academic staff as suggested by the Australian Committee of Vice-Chancellors and Principals

Cost items

1. Academic services (arrived at for each staff member by dividing total costs by total number of staff members)
   - Libraries, computing, animal houses, etc.
2. General university services (arrived at for each staff member by dividing total costs by total number of staff members)
   - Administration, postage, power, insurance, telephones
   - Maintenance, security, cleaning of buildings, etc.
   - 20 per cent consumables
3. Departmental office support (for each staff member)
   - 20 per cent of secretary's salary
4. Use of office space (for each staff member)
   - 15 m^2 * commercial rental rate for office space
5. Use of facilities and equipment (for each staff member)

• Laboratory space	• 30 m^2 commercial rental for laboratory space
• Technical support staff	• 17 per cent technician salaries
• Equipment	• Insurance value depreciated over 15 years

6. Academic salary arrived at for each staff member by dividing total salary cost (including social charges) by the total number of staff

Overhead rate

Non-laboratory-based staff	$\frac{A+B+C+D}{F}$
Laboratory-based staff	$\frac{A+B+C+D+E}{F}$

Source: Roderick E. Hurst, "Cost calculation and cost management of multinational research projects". In: *Higher Education Management*, July 1991, Vol. 3, No. 2, p.122.

Another methodology for determining overheads is proposed by the European Union for R&D contracts. Here overhead costs are required to relate to historic costs as well as to the site at which the project is carried out. In all labour-intensive activities, overheads should be recovered preferably on a per-head basis, rather than on a percentage basis of the grade or salary of the scientist working on a project. As a general rule, the European Commission allows for a maximum of 20 per cent general overhead of all additional (not total) costs incurred by a research project.

For a long time, the most common practice in higher education establishments in the United Kingdom has been that, for most average-sized research council projects, a reasonable approximation of full recurrent costs would be obtained by adding about 40 per cent to the direct costs. A regression analysis had shown that universities' total costs increased by 40 per cent of the additional departmental costs of research projects[6].

Adopting clear guidelines for the calculation of overheads is problematic for most higher education institutions. In most developing countries, such guidelines do not exist. Only part of the case-study universities mention that they have developed clear rules for the costing of projects. The **Hebrew University of Jerusalem** is one of these institutions. It is interesting to note that its overhead comes close to the one prevailing in most British universities.

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[6] Gareth Williams. 1990. *Changing patterns of finance in higher education*, p. 44. Buckingham, UK: SRHE/Open University Press.

Box 10. Costing guidelines for R&D projects at the Hebrew University of Jerusalem, Israel

Salaries	: Chief researcher, researchers, technicians, secretarial workers
Equipment Materials	: Permanent, expendable, glassware, other, computers
Others	: Seminars, professional literature, trips, various
Overhead	: 35 per cent.

It is important to note that Yissum charges the industry, for any research contract, an overhead of 35 per cent above the budget presented by the researcher and needed for conducting the activities of the project. The figure of 35 per cent has been determined as a compromise between the real costs to the university and the ability of industry to pay these costs.

At the Technical University of Lodz, where the management of relations with the private sector is organized in a highly decentralized manner, with only a limited and often negotiable set of rules, overheads are charged in the range of 30 to 40 per cent, which is transferred to the university budget and to the institute or department for the payment of different expenses. This overhead is, however, negotiable with the partner and may be up to 50 per cent. Apart from the overhead of 30 to 50 per cent there is also a 'profit' for the scientific workers and 30 per cent for services. This profit is negotiable and may amount to 50 per cent or more. All these amounts may also be negotiated with the Rector's Office and the Financial Office.

3. Distribution of generated income

The distribution of generated income is a very important aspect of the management of university-industry relations. It is a major tool for the motivation of different actors to commit themselves to joint or service activities. For individual academic staff, it is an opportunity to supplement their salaries. For the department and higher education establishment, rules for the distribution of income determine the extent to which a financial margin can be created for future projects within a department (in the case of a devolved budgeting system) or just to respond to urgent financial needs at the departmental level.

The internal distribution of income generated from collaboration with the private sector represents also an interesting lever to avoid ever growing internal fragmentation of the university. Obviously, some university departments are operating much closer to the market than others and have such a high potential to generate income, whereas others may not at all. One can easily imagine a department of business administration with numerous opportunities for consultancies and continuous professional development, whereas the department of history is much more limited in this respect. The percentage of the generated income that remains at the institutional level can be redistributed for project activities to have units benefit from them. Such a distributive policy at the institutional level is of course a matter of social acceptability within a university, but it may be an important instrument to maintain a certain degree of internal cohesion.

These internal rules for the distribution of income need to be known by all stakeholders and they need to be perceived as fair by them. It is a matter of fact that there are frequent tensions between individuals, departments and the central administration of higher education establishments on the allocation of generated surpluses, and the use of departmental discretionary funds. Such tensions can be very counterproductive to the development of sustainable university-industry linkages.

In this respect, the case studies have allowed us to identify *two* major models of income distribution:

Distribution of income gained from the commercialization of patents and from royalties

Only three case institutions of the 12 case studies, i.e. the Hebrew University, the University of São Paulo and the Autonomous National University of Mexico, have been able so far to develop policies, structures and procedures for the commercialization of intellectual property, which can generate quite considerable amounts of income, as was demonstrated for HUJ. Among the procedures, they have put in place clear rules regarding the ownership of the intellectual property and the distribution of income generated from such commercialization. The establishment of such rules is of prime importance in higher education establishments with a strong research base, since IPR can generate substantial income.

Box 11. Distribution of income generated from royalties at the Hebrew University of Jerusalem, Israel

The Hebrew University of Jerusalem, for instance, distributes income collected from royalties in the following way: 33 per cent goes to the researcher/inventor privately as a direct incentive, 33 per cent goes to research at the university, 33 per cent to the university via Yissum (external interface) for general budgetary use. It is important to stress, however, that the 33 per cent which goes to research is used for the funding of other research projects managed by the same scientists who were responsible for the generation of this income. This is to create a supplementary incentive for researchers to attract external funding (in a highly competitive research environment) and to perform adequately in the implementation of the research project. One can say that, according to the formula used at the Hebrew University, 66 per cent of the royalties are transferred to the researcher and only 33 per cent stay at Yissum, which conducted the negotiations with the enterprise; dealt with patent licensing and gave all other administrative support to the researcher. The rationale for such a contribution is to provide incentives to the researcher-inventor and to remunerate the university and Yissum for their contribution to the implementation of the project.

Box 12. Distribution of income generated from royalties at the Autonomous National University of Mexico

A Policy for the Administration of Intellectual Property and Regulations for Extraordinary Income has also been elaborated at the university; it has established principles to allocate resources obtained from the exploitation of technologies and the provision of specialized services for industry. The rule was established that the industrial property of all research results obtained as part of the university's research effort belongs to the university, which is responsible for filing patent applications when applicable. The extraordinary income generated by the licensing of rights for exploitation of industrial property, once the costs incurred have been deducted, are distributed among the individuals participating, the division they report to and the central administration of the university in a 40-40-20 per cent relationship.

Distribution of income gained from the overhead or generated surplus

In institutions which are not yet involved in the management of intellectual property, income is generated as part of the pre-fixed overhead rate or as a distribution of the surplus, i.e. the difference between expenditure and revenues, established after closure of accounts. The following rules prevailing at the case institutions demonstrate a wide range of practices, both with regard to flexibility in the setting of the individual amounts that go to different stakeholders, and to the exact amounts.

These differences are partially due to the different types of services and activities that are conducted. For instance, the more labour intensive an activity or a service, and the less it involves research infrastructure and laboratories, the more likely a major share of income goes to the research worker. On the contrary, the more equipment and laboratory based an activity, the greater the amount of income that goes to the university or the department (in the case of devolved budgeting).

Another factor is the existence of an interface, which takes care of the administrative tasks related to a project or an activity and whose remuneration needs to be financed from the overhead provision.

All 12 case institutions have adopted rules and procedures for the distribution of generated income. These rules and procedures can be classified into three different modes according to the stakeholders, i.e. institution, department or the individual, that benefit most.

The first group, composed of the Hebrew University of Jerusalem, Lodz Technical University and Suranaree University of Technology, revert a majority of generated income back to the central university budget.

- At the **Hebrew University** the distribution of generated income is done in the following way: for any research contract, there is an overhead of 35 per cent above the budget presented by the researcher and needed for carrying out a contractual research. The 35 per cent overhead is used as follows: 7.5 per cent to Yissum to cover its general costs; 20 per cent to the university where the research will be conducted; 7.5 per cent to the department where the research will be conducted to cover the general costs, to buy new equipment, and, more generally, to gain the department's goodwill to support the research, which adds a significant load on the general infrastructure of the department.
- **Lodz Technical University** stated that "about 30-50 per cent of the income is transferred to the university budget and part of it returns to the institute for payment of different expenses. The rest of the income is used for purchasing the research materials and equipment and part as an extra income for the team of researchers or technicians".

- At the **Suranaree University of Technology,** the internal distribution of income for organizing activities with outside enterprises is simple: in the case of training activities one part (about 60 per cent) is used to cover the expenses spent on the organization of the activity which includes the speaker's fee and travel allowance, overtime payment for staff, consultation fee, coffee-break charges, photocopying service, and rental fee for the venue; the rest of the income (about 40 per cent) goes to the university's central funds. This proportion is applicable when the university alone organizes an activity. However, when the activity is jointly organized with another outside enterprise, the agreement has to be made each and every time about the criteria for distribution of income and how much would be received by both parties. Generally, the university will have the lion's share (more than 50 per cent) if it offers the venue for such an activity. If not, the enterprise involved gets a higher amount than the university. Nevertheless, SUT has not so far fixed the rates for distribution of internal income. They vary from time to time, depending on other factors, such as the nature of the activity and the budget involved. Suranaree University has recently set up a committee to look into distribution of income from intellectual property rights.

A second group of institutions composed of the University of São Paulo, the Autonomous National University of Mexico (UNAM) and the Faculty of Engineering of the University of Cairo distribute revenues equally between the unit (school or faculty) involved in the research and the individuals managing and conducting the research.

- At the **University of São Paulo**, until March 1998, there was a flat overhead fee of 30 per cent of the salaries of academic staff to be reverted to the department. The proposal to adopt a more flexible distribution was made by an ad-hoc commission established at the central university level. The main rationale was to design a new rule that would be able to take into account the different uses of infrastructure made within a project, e.g. for a Chemistry and a Management Faculty. It should also provide room to cater for different cultures prevailing in the university schools and institutes. Two main principles have been adopted by the university Commission: *(a)* a low floor for the contribution to the academic unit (10% as compared to formerly 30%); and *(b)* allow flexibility – the academic unit may charge between 10 per cent and 50 per cent, according to internal criteria. The University Fund for Research/ Extension receives a 2.5 per cent cut on the amount of each contract (not applicable to the equipment and construction components of a contract); the school may charge an additional fee according to its own criteria, such as the use of facilities (before, there was a uniform 2.5% fee). Finally, the school charges a fee between 10-50 per cent of the personal income of its staff in projects, keeping 95 per cent of this amount and forwarding 5 per cent to the research/ extension fund. In case of economic benefits from industrial property, 50 per cent remains with the university and 50 per cent goes to the inventor.

- At **UNAM**, income from both contract research and technology transfer existed before the creation of the Centre for Technological Innovation, at least in some of the university's divisions. All income is registered in the university's Office of the Treasurer and credited to the account of the specific unit responsible for its generation. A 20 per cent 'tax' is retained and destined for institutional priority projects, while the remaining 80 per cent is autonomously managed by the originating unit and spent as required by the project's needs. The participating staff is eligible to share in the surplus, in accordance with specific rules established by each unit's internal Council.

- At **Cairo University**, "the faculty cashes 20 per cent of the value of each contract against space, logistics and services provided to the centres (internal interface). This amount is split equally between the university and the faculty. The remaining is spent according to the terms and conditions of the contracts and according to the internal rules of each research centre, usually to cover purchase of equipment, travel expenses, paperwork and remuneration of consultants and helpers."

The third group of institutions, composed of the Papua New Guinea University of Technology, TECO of the Faculty of Engineering at the University of Makerere, and the Ecole Supérieure de Technologie of Casablanca, give clear priority to the motivation of individual academic staff for joint projects since the major share of income goes to them.

- At the **Papua New Guinea University of Technology**, the distribution is the following: 65 per cent goes to the university staff consultants involved, 25 per cent to the interface UDC, and 10 per cent to the department.
- Projects conducted under **Makerere's** interface, TECO, use the following distribution of income: 51 per cent of the net income of any work executed and completed goes to the consultants who perform the job, 30 per cent is for TECO shareholders (i.e. academic staff of the Faculty of Technology), 12 per cent is for the Central Administration of the university and 7 per cent goes to the Project Administration.
- At the **Ecole Supérieure de Technologie (School of Engineering) of Casablanca** the following distribution of income has been adopted: 10 per cent goes to the budget of the institution, 10 per cent is reserved for future activities in the area, 20 per cent is foreseen for the implementation of the contract, and 60 per cent goes to the university staff (consultants).

The above-mentioned accounts of rules and regulations, which are more or less flexible, demonstrate that there are different underlying conceptions of how work with external partners should be rewarded. One conception is that external income generation is part of the normal activities of the university. This conception seems to have been adopted by Suranaree University of Technology or by Birla Institute of Technology and Science (BITS). At BITS, all collaborative activities with industry have been institutionalized and they are part of the mainstream activities of the university. Hence staff members are assigned workloads for such activities which may replace regular teaching or research on campus. As a consequence, staff members receive extra pay only if they work overtime on projects. This bears with it the problem that many academics do not agree that collaborative projects are part of their normal workload, and they might lack motivation to commit themselves to such activities.

Most other case institutions, such as Papua New Guinea University of Technology, the University of Makerere, and the School of Engineering of Casablanca, treat income generation as peripheral to the mainstream activities of the institution. In order to motivate staff, a major share of generated surpluses go to the involved academic staff and not the employer institution.

The third approach, adopted by the Hebrew University of Jerusalem, the University of São Paulo, and the University of Lodz, shares generated income more or less equally between the institution, the operating unit and the individuals earning, according to a formula. This approach aims at the motivation of individual staff, but also takes account of the fact that institutions or departments lend their infrastructure to those activities and need to be compensated for this. This last approach seems to have become the most popular approach for generating income since it tries to reconcile all interests in income generation.

The question arises whether there are guidelines for a desirable distribution of income generated from collaboration with industry. As already mentioned above, it is good to have university-wide rules. These rules should allow, however, for flexibility to be adapted and preferably agreed upon at the local level within a fixed range. If there is too much flexibility, this might provoke never-ending discussions and sometimes growing tensions between different stakeholders within institutions. Otherwise, the amounts that go to the different stakeholders are a matter of convention and prevailing value systems at the institutional level. They reflect both local cultures and policies as well as particular circumstances related to the type of activities and services that are rendered.

4. Risk and venture capital

Often, R&D projects with industrial partners carry with them a considerable economic risk, in particular if the project is aiming at the development and the exploitation of an invention. A university can only enter in the exploitation phase of a product, if it is able to pre-invest and to bear an economic risk. The availability of capital to finance risky collaborative activities and the possibility to use it with a considerable amount of autonomy then becomes a *sine qua non* condition. The Hebrew University of Jerusalem and the Autonomous National University of Mexico report the creation of such capital funds.

The Hebrew University of Jerusalem has recently created a 'venture capital fund', many of which were developed as a tool to finance the high-tech industry in the USA about 15 years ago. In Israel it has become a major vehicle to finance start-ups and companies during the last five years.

Box 13. The 'Venture Capital Fund' at the Hebrew University of Jerusalem, Israel

A Venture Capital Fund is actually a Limited Partnership and it is an entity that manages other people's money. Usually these funds are 'close funds', which means that after 7 to 10 years the fund will be totally liquidated and the money and/or other values will be distributed to the investors whose money was invested by the fund, according to their holdings.

The basics of Venture Capital Funds (VCF) are that they will not assume majority in any company (their management will not look to control a company) and they will look to invest in such companies where they will get very high returns on investment (50 per cent ROI is expected in the time of investment).

The money which is being invested by a VCF originates from private investors, from various companies that would like access to new technologies, and others.

The VCFs that were established in Israel during the last five years were able to collect from various sources in Israel and abroad over US$2 billion. About US$1.3 billion have been invested to date, and 3/4 billion is still available for investment. A new VCF was established last year and it has US$0.5 billion under management, looking where to invest.

VCFs can be in various fields of interest, they can be of a certain level of money under management (a few million dollars or hundreds of million dollars) and they can be of any mix of investors. The parties that invest in the VCF distribute their risks and provide their funds to professional managers, who choose to invest in companies/start-ups with potential of high return on investment.

The VCF, although not looking to invest in the seed stage, has a major impact on the ability of a university's project to become a product.

The VCF's scope of activity reflects the university-industry relations and adds new angles that did not exist a few years ago. The new start-up companies generate, very rapidly, new technology, raise money in the stock exchange markets, look for sources of new technologies and for scientific services (i.e. universities) and push the industrial sector to look rapidly for new technologies and to work in parallel, thus approaching universities to conduct research that will provide needed answers.

Over the years, Yissum has developed financial tools and funds to support a research project directly or to attract industry in a joint investment.

Lately the university has established, together with Yissum, a Venture Capital Fund to encourage more new applied projects within the university research framework.

The US$5 million Fund is aimed at bringing general ideas developed by university researchers to a more advanced stage, where Yissum would be able to offer industry a more advanced technology and thus to commercialize it on better terms.

The university researchers approach Yissum and provide a research plan describing background, commercial potential and budget needs and Yissum analyzes the potential and provides financial support to those projects with the highest potential of attracting industry.

A similar mechanism has been created at the Autonomous National University of Mexico, where a relatively small risk capital trust fund has been pulled together by funds from both the university and a private bank. Here funding is not provided to new start-up firms, but to existing enterprises who intend to commercialize a university product.

Box 14. The SOMEX/UNAM Trust Fund of UNAM, Mexico

The Centre for Technological Innovation detected the need to have a specially flexible, agile financial mechanism to facilitate access by interested enterprises to the resources necessary to cover the costs UNAM would incur in projects of interest to them. To this end, the SOMEX/UNAM trust fund was created with initial assets equivalent to approximately US$425,000.

The SOMEX/UNAM trust was first conceived as a credit mechanism to loan money to enterprises interested in applying some university-developed technology, but incapable of financing on their own the development phase or the transfer costs. It was started with contributions by the university and the bank, and a decision-making mechanism was established to allocate funds to specific projects on the basis of their expected profitability. Specific terms were negotiated for each case, establishing the reimbursement commitments and procedures. The recovered funds were expected to be reinvested in future projects.

The discussion of financial instruments such as Joint Venture Funds and Risk Capital Funds leads to a more profound questioning of what constitutes the mission of the university and whether the commercialization of inventions should be the business of public higher education institutions or private enterprises. These are, of course, questions which relate to personal belief systems and ideology, and to prevailing values that are linked to national traditions and culture. However, in a context of financial stringency and governmental requests for relevance, institutions are increasingly driven to become active in non-traditional stages of the innovation process, i.e. in the exploitation of their inventions, since the financial benefits can be substantial.

The financial management of relations with industry includes many other important questions, such as an appropriate organizational structure for financial management in general, and the issue of devolved budgeting and management in particular. Devolved budgeting and management of generated funds by the departments themselves is high on the agenda these days as a mechanism to raise ownership and cost-consciousness among those who are the main players in university-industry relations, that is the academic staff. Obviously, the more decentralized the financial management to departments, and the more autonomy given to them over deciding how to use generated surpluses, the greater the motivation for such units to engage in relations with the productive sector, since they are the direct beneficiaries of their work.

Appropriate accounting systems to enable good financial monitoring of projects are another crucial concern. Traditional accounting systems often do not manage core funding and university-industry projects separately. As a consequence, it is difficult to know at any point in time if such relations are profitable, since project revenues and expenditures cannot easily be compared. Accordingly, it is advisable to establish separate accounting.

Another issue of considerable importance to financial managers of university-industry projects is that of Value-Added Tax (VAT). This is an example of a crucially important item in the daily management of projects, since VAT constitutes an important element in the determination of the price a higher education institution is able to offer for a given service, often in comparison to a private provider. However, VAT, accounting systems and the organizational structure for financial management are very much related to local or national circumstances and rules. As a consequence, they may not be dealt with appropriately at the international level.

6. PERSONNEL MANAGEMENT

The development of relations with the productive sector depends on university staff who are willing and capable of entering into fruitful and long-lasting relations with enterprises. In those institutions where such relations are conducted on an ad hoc or personal basis, it is in particular those staff with work experience in industry who are the most active. This observation shows that knowledge of the partner's working environment and culture is a very crucial success factor for building up a fruitful sustainable relationship between universities and the productive sector. Other key factors are the commitment and creativity of staff. Commitment is necessary to guarantee the long term viability of linkages and creativity is necessary to keep it active.

Within the framework of a growing institutionalization of university-industry relations, the former chapters have demonstrated that the management aspects, both at the strategic and operational level, tend to be increasingly concentrated in the hands of professional managers. Such professional managers are involved in the marketing of potential products and services. They also collaborate in the negotiation and costing of projects, in the management of intellectual property rights, and many other matters, according to the division of tasks and responsibilities adopted in an organization. The range of competences that are required from professional managers of university-industry relations is ever widening. As a consequence, appropriate staff recruitment and development in these domains are very important aspects of personnel management for developing university-industry relations.

But it is not only the managers of university-industry relations that need particular competences, but also the academic staff themselves. One can easily argue that participation in a project with industry is already some kind of staff development, because it allows a staff member to get involved, usually on a voluntary basis, in a practical activity related to his/her teaching and research and study activities. This is in itself a value added from collaborative projects. Institutions, however, also have to protect themselves from undesirable effects such as staff neglecting their professional duties, with regard to teaching for example. As a consequence, staff management rules and procedures need to give guidance as to the amount of time staff members are allowed to spend on projects with the private sector. But, as usual, the existence of rules is one thing, finding mechanisms for having them adhered to is another matter.

This consideration leads us to a third major topic in the personnel management of university-industry relations, less concerned with necessary competences than with motivation. Higher education personnel, and academic staff in particular, need to be involved in appropriate reward and incentive systems to attract and maintain quality staff within higher education institutions. This issue relates, of course, to the above-mentioned financial incentives created through rules for the distribution of income. There are, however, other financial incentives that may be deployed by higher education institutions, which will be discussed below.

1. Staffing and staff development

The growing diversity of tasks in higher education institutions, one of which is collaboration with the productive sector, has in many cases also led to changes in employment conditions. In the past, the predominant model was the tenured academic staff along with younger assistant staff preparing their theses and awaiting permanent employment. Today, in many collaborative projects, especially in the R&D area, temporary staff are employed, tied to the funding of a particular project. With regard to consultancies and short training programmes, such staff are usually paid on an hourly basis, be they staff already employed by the university or outsiders. It is quite frequent nowadays that tenured staff work together with temporary staff within the same project, since employment conditions in the higher education sector, very much as everywhere else, tend to become more and more precarious. Often, the temporary staff are young academics who have not been able to find permanent employment in a university. The coexistence of permanent and temporary staff often creates tension, especially since permanent employment after temporary employment tends to become less and less the rule. In order to be able to maintain temporary staff of a high calibre, one of the most important challenges of personnel management is to design employment conditions and career prospects for staff that reduce the gap between tenured and temporary staff. This is necessary to maintain a peaceful environment based on equal treatment of all staff in an institution.

In the United Kingdom, for instance, the Committee of Vice-Chancellors and Principals (CVCP) and the Funding Bodies have adopted a *Concordat* which binds those higher education institutions that sign it to a number of standards in the personnel management of their contract staff. These rules relate to the provision of in-service training and continuing development for researchers at an early stage of their research career, appropriate performance management through supervision and regular review by senior researchers, as well as career guidance and development[7]. The joint interest of the CVCP and the research bodies is of course to offer fair treatment to young researchers, but also to try as much as possible to maintain the best of them in public research structures.

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[7] A *concordat* to provide a framework for the career management of contract research staff in universities and colleges, CVCP Home Page at *niss-professional@niss.ac.uk*, 10 June, 1997.

Beyond the issue of employment conditions, a personnel policy conducive to the development of relations with industry needs to identify new tasks and roles to be performed by both managers of university-industry relations and academic staff, and confront them with new competences required to perform adequately such tasks, i.e. continuous professional development, research and technology transfer, consultancy and income generation. It is important to identify the existing staff who can do these tasks well at present, and others who should be given training. This includes also external specialist appointments where internal competency is not sufficient. Then, it is necessary to provide systematic training for new tasks such as CPD pedagogy, consultancy skills, marketing for administrators, costing of projects, etc. These require very specific competencies which need staff with specialized management training and knowledge of the private sector. Such creative personnel management requires a determined executive management, an imaginative personnel department, a financial margin for personnel costs and wide-ranging administrative autonomy at the institutional level, for instance with regard to new recruitments.

Such innovative and systematic personnel policies are more an ideal than reality. Among the case universities, only two institutions mention some kind of 'in-house' training provision, and a third a systematic placement scheme for academic staff in industry. The University of São Paulo has a unique training programme (known by its acronym PROTEU) for university-industry interface managers, open to university staff, company professionals and agency personnel. This has been a successful initiative, with a strong attendance of university liaison managers from other Latin American countries.

The mission of the Centre for Technological Innovation of UNAM is to perform as an internal support structure for technology transfer and an academic training centre for students and staff. In the period of 1983 to 1993, CIT organized around 150 training activities for 3,000 participants in areas related to planning and administration of research and innovation. It designed its own courses and also participated in the development of a distance-education course option for small-scale entrepreneurs.

The practice school scheme of Birla Institute of Technology and Science, which provides for staff and student placements in a given number of associated enterprises, offers ongoing staff development to its faculty. Through the placement periods in industry and joint collaboration with R&D staff of the private sector, the BITS faculty is periodically exposed to the reality of enterprises and to the work that they must train their students for.

However, despite the fact that the issue of staffing and staff development for university-industry relations is a crucial aspect, this domain is tremendously underdeveloped in most, however dynamic, institutions. This is probably due to the multiple requirements on staff development of all kinds existing in higher education institutions, and the fact that academic staff members are more likely to request development opportunities linked to research (travel abroad, sabbaticals) than a training course in technology transfer.

2. Incentives

As mentioned earlier, in most higher education institutions, collaborative projects with the productive sector do not belong to the traditional mainstream activities of such institutions. For this reason, few incentives exist to motivate staff for such activities beyond their intrinsic motivation to apply their knowledge and expertise in co-operation with an industrial partner. It is certainly fair to say that there will always be a certain number of highly motivated individuals who, for reasons of professional interest, will be active in this domain. However, one can also assume that it is difficult to implement an institutional policy of developing relations with the private sector without creating institution-wide staff incentives.

Three types of incentives can be distinguished:

Financial incentives

Financial incentives comprise mechanisms such as an agreed proportion of generated income from intellectual property rights, project surpluses or an honorarium (daily or hourly) or fees attributed to academic staff. Above, we have already partially tackled the issue of income distributed from Intellectual Property Rights or surpluses. Another type of financial incentive may be a salary complement such as those granted by the Hebrew University of Jerusalem to staff committed to projects with industry.

Box 1. Financial incentives for staff at the Hebrew University of Jerusalem, Israel

A financial tool has been developed at the Hebrew University to motivate staff to collaborate in projects with industry. This tool is an agreed scale which enables the university to calculate automatically an addition to the researcher's salary, which takes into account the size of the extra-budgetary funds attracted by the researcher and the type of the enterprise. When a contract is signed with a *'For Profit Organization'* (for example an industrial enterprise), the researcher can expect to get up to 50 per cent addition to his salary (assuming the project is 'big'), even if he is involved only with one such contract. If he attracts more extramural funds, he may expect to get a higher addition to his salary, up to a maximum of 90 per cent.

The addition to the researcher's salary is calculated more precisely in the following way:

There are three types of research funding sources: those which are coming from the university current budget or other university-related sources, which will be defined as 'Type 0'; sources which are related to 'non-profit organizations¡, including governmental ministries or agencies, which will be defined as 'Type B'; and sources which are related to 'for-profit organizations', including industries and many research funders from abroad, which will be defined as 'Type A'.

When an HUJ academic staff member obtains a research grant of 'Type 0' he or she will not get any additional salary for that.

If the staff member obtains a research grant of 'Type B', he or she will be entitled to a salary addition on the following scale:

- Less than US$6,000 = nothing
- US$6,000 - US$12,000 = additional 6 per cent
- US$12,000 - US$20,000 = additional 12 per cent
- US$20,000 - US$45,000 = additional 20 per cent
- Over US$45,000 = additional 25 per cent.

In the case of 'Type A' grants, the following salary additions will be applied:

- Less than US$6,000 = nothing
- US$6,000 - US$48,000 = additional 30 per cent
- US$48,000 - US$75,000 = additional 40 per cent
- Over US$75,000 = additional 50 per cent.

When a researcher obtains more than one extramural grant, a formula is used which is a little more complicated, to calculate the size of the salary addition. It is not a simple mathematical calculation of the separate additions related to each individual grant the staff member has obtained, but it is definitely a significant sum. However, the maximum addition that a staff member can expect to get is not more than 90 per cent to his salary (when the staff member obtains many research grants) and not more than 50 per cent when the staff member obtains one single extramural grant.

Since industries are always 'for-profit organizations', their grants will entitle the staff member to a higher addition (Type A). A scientist who obtains several industrial grants can quite easily almost double his or her salary.

There are rarely cases of dissatisfaction or misuse of the formula.

Promotion criteria

It is widely known that career progression in most universities is based on the number and the quality of publications. In particular, decisions over a fixed-term employment or tenure depend widely on this practice. Collaboration in projects with industry is time consuming, sometimes not professionally rewarding (in particular if it is collaboration with the SME sector) and, generally, collaborative projects are not taken into account for promotion, as mentioned by nearly all case-study institutions.

The Birla Institute of Technology, University of São Paulo, and the National Autonomous University of Mexico acknowledge this problem and all three have started to address it. They have adopted rules, or are in the process of doing so, which acknowledge the particular contribution of a staff member in the development of university-industry relations.

BITS, for instance, has made extension work a part of the mainstream activities evaluated through a university-based process comprising a staff member's self-evaluation and an evaluation of his/her superiors.

Box 2. Promotion criteria for collaborative activities at BITS, India

Promotion of collaborative projects with the production sector do require well-planned schemes which must include incentives for motivating the staff. This will be done more by recognizing the importance of the work than simply giving additional financial benefits. It is essential that people involved must get a feeling that their work has equivalent value compared to work done by people who are not involved in this type of activity but are publishing papers in traditional areas. With this background, in all promotional criteria of BITS, equal weight is given for teaching and research as well as activities involved in university-industry linkages.

The promotional decisions in the institute are made by a committee appointed by the Board of governors, which will consist of the director of the institute, deputy directors and also an external member. However, this committee will act on the recommendations, based on various data, given by a number of division heads in the institute. The process includes both qualitative and quantitative indicators. While it is difficult to describe the minute details, given below is a broad outline.

The following are the important criteria for making decisions on promotions. (As a matter of fact, since all the posts are contractual posts, they are also factors in deciding about the continuance of the faculty with the same positions):

1. *Teaching – effectiveness and innovations:*

   This is judged by course planning, delivery, preparation of course notes, innovative pedagogy and evaluation methods, etc. Recommendations on these factors are given by the Dean of the Instruction Division who uses, among other things, students' feedback.

2. *Research:*

   The number of projects and theses guided, number of Ph.D.s guided, number of papers published, and participation in subject conferences are judged. The recommendations are given by the Dean of Research.

3. *Involvement in internal administration, co-curricular and extra-curricular activities:*

   These activities include registration, counselling of students, acting as hostel wardens, motivating and guiding students towards social and cultural activities, sports, etc. The recommendations on these are given by the Dean of Academic Registration and Counselling, the Dean of Student Welfare Division, the Chief of the community welfare unit, etc.

4. *Involvement in university-industry linkage activities:*

   These activities include participation in the practice school programmes of the institute, technology innovation centre, industry consultancy, special course development towards industry-based courses, participation in off-campus distance-learning programmes, etc.

The recommendations on these are given by the Dean of the Practice School Division, the Dean of the Distance-Learning Programmes Division and the Dean of the Educational Development Division.

The actual process involves a self-assessment report submitted by each faculty describing all the achievements in all the above criteria. These reports are also evaluated by the concerned divisional heads and they also submit their assessment of the faculty in the above criteria. At the time of promotional review, which normally takes place for every faculty every five years, all these data are accumulated and, through a general notice, a request is made to the faculty to submit any additional data if they so desire. Any faculty member is also allowed to give independently, in a confidential manner, his assessment of any other faculty member, with supporting data. This also will be used. Ultimately, all attempts will be made to make the process transparent and to inform the teachers in confidence of the final number arrived at for the decision for promotion. So far this has worked, up to a satisfactory level of 95 per cent.

The University of São Paulo has decided to officially take into account extension work for decisions on promotion. Currently, there are still many problems regarding the importance to be given to such work, and the quantitative values that should be given to such commitment.

Box 3. Promotion criteria for extension work at the University of São Paulo (USP), Brazil

There has been a chronic problem at USP of valuation of extension activities - co-operation with industry or any other extension work - both in the career advancement of faculty and the departmental appraisal. This has raised tensions between the internal evaluation bodies - dominated by the 'publish or perish' concept, and professional schools of USP, which emphasize market demand and actual technology transfer as yardsticks of competence.

An important step was taken in 1995 by the Central Council for Culture and University Extension, through an initiative of the then Pro-Rector, and currently Rector, when 13 categories of extension were legitimized for evaluation purposes. The current challenge is to establish a quantitative value to each activity, to allow for direct point counting in competitive situations, e.g. between two or more candidates for one vacancy of full professorship.

The Autonomous National University of Mexico underwent a similar process as the University of São Paulo. The UNAM case study demonstrates how much a change in the promotion criteria represents a change in culture. It is also an issue leading easily to overt internal conflict and unrest within the academic community.

Box 4. Promotion criteria for technology transfer at UNAM, Mexico

It became evident that the transfer of research results was not only a complex communication process that needed to be understood more deeply, but also demanded certain organizational adjustments within the university itself, since new functions with economic added value were called for.

Consequently, during this period new procedures and instruments of an administrative character were designed and established which were aimed mainly at the creation of a new organizational culture within the University to foster technological development.

A proposal entitled 'Criteria for the evaluation of academic work' was drawn up and presented for discussion in the academic community. The proposal was formulated in response to the unrest shown by some researchers with respect to the award of merits accruing from technological work, in contrast with the traditional criteria of peer evaluation and the publication of articles subjected to review by referees in specialized journals in assessing scientific work.

The evaluation of the academic staff was modified in such a way as to:

- Recognize as valuable both the participation of academic staff in generating new basic knowledge, and obtaining technological results with potential application in the productive sector.
- Assess the creative contribution of knowledge organized in pertinent 'technological packages' (the set of all the information necessary to repeatedly apply the knowledge transferred to productive processes in a way easily understood by personnel in the enterprises) as the basis for the evaluation of technological merit.
- Judge the actual successful implementation of such technological packages as an indicator of a valuable contribution.
- Assess the rationality of the problem definition, the quality of experimental work, the rigour in the analysis and formulation of the solution, and the importance and quality of results, as representative of the value of the researcher's contribution.
- Consider the impact in the solution of national priority problems, the contribution to the state-of-the-art and the development of local capabilities as the basic criteria to judge the relevance of the research programmes and activities.

Material incentives

It is often difficult to attempt to change staff statutes, in particular if they are part of civil-servant statutes, which need change at the national level. The above-mentioned cases are all examples where decisions on promotion criteria are a matter of institutional decision-making, In many cases, it is easier and more immediately applicable to grant those staff members active in collaborative projects, access to a favourable working environment. This may include access to better-equipped facilities such as refurbished rooms, office equipment, scientific equipment or travel grants. One can sometimes see that in those departments which are very active in collaboration with enterprises, space is nicely arranged, there is better office and laboratory equipment and there are better opportunities for travel abroad, etc. This has been mentioned by Bogaziçi University.

Box 5. Material incentives for staff engaged in university-industry linkages at Bogaziçi University

The faculty which engages in university-industry links, does so more for financial reasons and the prestige it brings, than for other reasons. Such efforts rarely result in publications and do not constitute a factor in academic promotion. Consequently, it is likely that those faculties who do not feel financial need, will have little incentive to develop links with industry. It is only recently that an appreciation of such relations is developing. However, the salaries being what they are, the financial rewards are still the top incentive for becoming involved in continuing-education courses or consultancy. A faculty member can earn up to 65 per cent of the income personally in this way. On the other hand, bringing funds to the university leads to certain unwritten privileges, such as more support through BUVAK, priority in maintenance of the premises of active departments, and in allocation of staff or assistant support.

The above-mentioned account of incentives demonstrates that only a few institutions have put in place salary complements as utilized at the Hebrew University of Jerusalem. With regard to financial incentives, staff members involved in projects with industry generally receive a honorarium (most frequently based on an hourly rate of remunerated work) or an established share of generated income from surpluses or income generated from the commercialization of intellectual property. Some institutions, such as HUJ, lay major emphasis on financial incentives, which are perceived to be the most effective means to encourage staff. They combine several types of financial incentives, such as salary complements, honorarium and a share from the exploitation of intellectual property rights, to motivate their staff.

A change in promotion criteria is still relatively rare and faces external and internal resistance. Those institutions which are able to modify staff statutes are tackling this issue, but they encounter opposition from staff members with more traditional attitudes. As a consequence, institutions generally rely on more informal incentives, providing priority access to resources which are distributed in a more informal way, such as access to travel grants, refurbished office space, equipment and the like. This illustrates that institutional managers also have a considerable informal margin to create incentives for their staff to foster activities linked to institutional priorities.

3. Protection of rights to publish

The cultural differences between universities and industry, based on the different objectives they pursue, have been widely deplored as an obstacle towards the development of university-industry relations. There are indeed different time horizons for research outputs; short and definitive in the case of industry, long, indefinite and flexible in the case of academic staff. Industry searches for benefits of practical exploitation of results and optimum testing, compared with university staff who are searching for knowledge, new theories and thoroughness. The private sector generally prefers confidentiality in terms of research results, whereas university staff seeks to publish. For academics, it is essential to publish their research results, both for their career advancement and the development of their professional recognition and network. If a collaborative project has been able to create knowledge that has a direct or indirect commercial value, the interest of industry is of course to postpone publication as much as possible, at least until the research is evaluated and any patent application filed. Since confidentiality is a contentious issue in the negotiation of any R&D contract, it is generally part of the bargaining process that leads to the establishment of the terms of reference of a collaborative project. Companies generally offer assurances that agreement to publish will not normally be withheld up to an agreed time horizon specified as part of the terms of reference of a collaborative project.

It can be argued that a fruitful relation between a university and industry will exist only if both partners manage to preserve their interests and join hands on affairs of common benefit. As a consequence, a university needs to establish rules which guarantee the right of its staff to publish, within a given time-frame. Generally, such a time-frame will then be agreed upon as an item of a contract underlying a collaboration. The Hebrew University has established very detailed rules in this respect which are laid down in an administrative regulation.

Box 6. Publication of research at the Hebrew University of Jerusalem, Israel

Yissum has to ensure that the agreements it signs with business concerns safeguard the researcher's right to publish to the maximum extent possible. Master's and doctoral students whose research was carried out under an agreement with a business concern retain the right to submit theses and doctorates for evaluation and approval, as they see fit and in accordance with the accepted procedures of the Hebrew University.

The publication of a research study that was financed or is being financed by a business concern, or the transfer of any know-how whatsoever relating to this research, including information on the very existence of the research, is done with prior co-ordination with Yissum, and as required by the agreement between Yissum and the business concern financing the research. Under the agreement, Yissum can allow the concern financing the research work to clarify its position within 45 days of the date when notification was sent it of the intention to publish the research study that it financed in the scientific press.

Any opposition on the part of the business concern financing the research to the publication of the research in the scientific press is accepted if it can be proved, to Yissum's satisfaction, and with the approval of the Rector of the university, that such publication could prejudice the business concern's rights and damage its interests.

Notwithstanding the above, a business concern cannot delay publication in the scientific press of the results of a research project financed by it for more than six months. During this delay, the business concern financing the research may adopt requisite measures to safeguard the research results, including filing for a patent. Yissum is entitled to grant the business concern's request to delay publication in the scientific press for a further period of up to six months, if in the explicit opinion of Yissum's patent adviser the research results do not yet constitute the basis for a valid patent. The executive committee of the Research and Development Authority may approve a further delay in publication, upon presentation of a well-supported request by Yissum, if it can be demonstrated that publication in the scientific press of the results of the research financed by the business concern will cause direct financial loss to the concern.

The right to prevent publication of the results of research work for reasons of national security is reserved exclusively to the President of the university and the Rector, after they have weighed the arguments raised against the scientific publication of the research study for security reasons and have so decided.

As can be seen from the publication issue, Yissum acts here as an independent agent committed to the contract between industry and the university and committed to the project and its success.

This is a very clear case when Yissum should understand both the needs of the researcher to publish and the concerns of the industry about such publication.

4. Rules and code of ethics for the collaboration with industry

If it is important for an institution to design rules for the protection of its staff to publish, it is also important to protect the mainstream duties, i.e. teaching, research and administration, from being neglected by academic staff for the sake of private or institutional consultancies. In this respect, traditional rules are very different from one country to the other. In the former Soviet block, academics were not allowed to enter into any profit-making relationships with the private sector, whose size was negligible anyhow. In Latin America, universities tend to establish contractual arrangements such as full-time or part-time dedication to academic activities. In this case, employment contracts provide a frame of reference for the amount of time that can be dedicated to private work. In most cases, however, a certain amount of time to be allocated to private activities, such as consultancies, is tolerated or even considered as desirable in domains such as law, medicine and engineering, provided that academics meet their other commitments satisfactorily. After all, such activities can also be considered as professional development, since they allow the academic staff to gain practical insights which enrich teaching and also research. Often, private long-term consultancies need official approval by the head of institution. However, senior administrators are confident that any consultancy requiring substantial absence from the university will be known by the head of department or the head of institution.

In many cases, informal interactions with the productive sector represent an important means of individual researchers to upgrade their salaries. Higher education institutions may benefit from this interaction because it reduces the risk of brain drain for economic reasons. In many countries of the former Soviet block, such as Poland, where staff were not allowed to do any work outside higher education, such rules have now been abolished as a strategy to maintain staff within institutions. Nevertheless, the current management challenge is to set up and have staff adhere to procedures clarifying their obligations and responsibilities. A formula which is applied in many institutions worldwide, and also in several case institutions such as the Hebrew University of Jerusalem, or the University of São Paulo, is the 20 per cent one. Under this formula, a staff member is allowed, under certain circumstances and with the permission of the head of institution, to take one day off per week for private consultancy under the condition that work is not done during term time and that it should complement the research interest of the academic and his department.

Box 7. Outside consultancies at the Hebrew University of Jerusalem, Israel

Consultation services provided by a member of the academic staff to a business concern are a personal matter and impose no responsibility on the university and/or any of its agencies. They must be implemented in accordance with the university's standard procedures for consultation services, and their scope must not exceed one day per week. As part of such consultation, a member of the academic staff may pass on general know-how relating to his academic-professional expertise to the business concern he is advising, but may not pass on specific know-how that is the direct or indirect result of research that was carried out at the university and is the university's property.

The researcher may be requested to report from time to time to the Vice-President for Research and Development on the nature of his work as a consultant and details thereof, including the scope of his employment as a consultant. A member of the academic staff may not work as a consultant more than one day per week. A consultancy agreement in a field and/or on a topic connected to research being carried out at the university by the consultant for the business concern must be made through and with the approval of Yissum.

As a general rule, the university does not encourage members of the academic staff to hold active executive positions in business concerns and does not view such activity in a favourable light.

A member of the academic staff who wishes to serve in an executive capacity such as president, scientific director, etc., must receive prior approval (at the recommendation of the Dean of the relevant faculty) from the executive committee of the R&D Authority, or from a body authorized to do so by the executive committee of the R&D authority. Such approval may be granted only based on some criteria that were set for such purpose.

Notwithstanding the above, prior approval is not required when the company in question is owned by the staff member and has no other employees, provided that his activity in such a company does not exceed one work day per week.

It should however be emphasized that the existence of rules is only one aspect of the issue. It is necessary, but often not sufficient. The other aspect is to find mechanisms which allow an institution to make sure that staff adhere to such rules. Most institutions in developing countries face major difficulties with staff neglecting their university duties. This is often linked to the very low salaries which often do oblige staff to 'moonlight'. Supervision of staff and control of the compliance with their workload can only be done at the departmental level. However, heads of departments in many countries do not play a leadership or supervisory role and have no instrument for sanction or reward of their immediate academic colleagues. As a consequence, the existence of rules and procedures for outside work needs to be accompanied with management changes giving supervisory staff power to play their role with regard to other academic colleagues.

7. THE MANAGEMENT OF INTELLECTUAL PROPERTY

Higher education institutions are by definition knowledge-generating institutions. In many countries, they are the leading intellectual forces in their countries. Often, collaboration with industry leads to the creation of knowledge that has a commercial value and that could be patented. In an earlier chapter, we have seen that considerable income can be generated through royalties from patents and licences. In 1998, the Hebrew University of Jerusalem was able to secure an income of US$3.5 million from royalties alone.

The potential to deposit a patent within the framework of a university-industry collaboration depends, however, on many factors. In many developing countries, university-industry linkages are not concentrated on joint R&D, but on continuous professional development and consultancy services. Also, it has already been said that in these contexts small and medium-sized enterprises are the predominant type of enterprise and their technology needs are ill defined and relatively low level. The big multinational enterprises generally import technology which has been developed in their home countries. Finally, it is indeed very rare, in both developing and developed countries, that HEIs have a written IP policy. They hardly provide any training and advice to their academic researchers to help them identify intellectual property that should be protected and exploited. Even if they have a policy on intellectual property, they are generally lacking capacity and finances which would allow them to have inventions, usually of the pre-competitive stage of research, filed for patenting. As a consequence, the number of patents generated by residents is extremely low, particularly in developing countries.

Among the case institutions, the Hebrew University of Jerusalem is the most active in the management of intellectual property. Its subsidiary enterprise Yissum has developed over the years a considerable expertise in this domain which ranges from patent filing, the generation of licence agreements, to the negotiation of joint ventures with private capital for the commercial exploitation of an invention.

Box 1. Management of intellectual property at the Hebrew University of Jerusalem, Israel

Yissum deals with inventions produced by Hebrew University research. It registers patents and their utilization. Yissum represents the Hebrew University in all matters relating to commercial and industrial utilization of the results of the research conducted therein.

Yissum is empowered by the university, *inter alia*, to determine whether the university has rights in an invention of an employee; to decide whether to seek protection for the invention, including prosecuting in the name of the university, with the approval of the management of the university; to define the lines of action and the type of engagement regarding the commercial and industrial utilization of the patents and inventions, and to negotiate with commercial and industrial institutions or bodies and enter into any agreement in connection therewith; to manage and organize the rendering of services on a commercial basis, the commercial and industrial production and utilization of patents and inventions carried out within the university, for it or in connection with it; to define the rules regarding secrecy, including the conditioning of its action for the protection and the commercialization of the patents and inventions by restricting the publication of the inventions in writing or their disclosure by word of mouth.

Example: Research and licensing agreement

A new patent was registered on an invention in the field of a slow release drug for periodontal use. The inventors were three researchers from the university's School of Pharmacy and the Faculty of Dental Medicine. The new invention was filed as a patent by Yissum and was licensed to Israel Chemical Industries Ltd. (ICL).

ICL supported further research at the university laboratories including clinical trials and, in parallel, developed a production line in which the product would be produced under sterile conditions. ICL responsibility was also to develop marketing tools and to seek FDA approval and all other permits prerequisite to marketing the product.

Approval was granted and the ICL has formed a new subsidiary called Perio Products Ltd. which is producing this product, marketing it, developing new versions and providing technical services in the market. The total investment of the ICL from the very beginning until completion of the new production and approval by the authorities is estimated to be US$25 million. The researchers continue to be involved by means of consultation that they provide to Perio Products Ltd.

Yissum will soon collect royalties and, more important, a new high-tech company was formed in Jerusalem based on the research developed at the Hebrew University, which will provide relief to people throughout the world suffering from periodontal problems. The new company will provide jobs for more employees in Jerusalem and will increase the general industrial output and the GNP. The university will benefit from the royalties received. About 33 per cent of the royalties received will be invested back in research at the university.

The above example demonstrates the strength and the importance of generating contacts and contracts between the university and industry.

The Hebrew University has also established very clear rules of secrecy for researchers to adhere to concerning knowledge generated through university-based research projects. The university reserves the right to sue its employees for damages on account of such know-how or services supplied to a business concern not via Yissum. Any specific know-how that could be accumulated in the course of research is the property of the university. Also, any negotiations between an academic staff member and a private enterprise aimed at entering into a contractual relationship has to be conducted only with the approval or the participation of Yissum. It is the rule that knowledge created within the framework of university-based research projects is considered as university-owned.

All other institutions refer to the issue of protection of intellectual property as an important one that needs to be addressed. However, few institutions have designed clear-cut rules and regulations in this respect, such as to whom ownership of intellectual property should be granted (the institution, the individual researcher or the collaborating company) and who will benefit financially from it.

Most other case institutions foresee some kind of joint ownership of intellectual property. The University of São Paulo, for instance, accepts shared ownership of intellectual property. At this institution, intellectual property issues are managed by a small specialized structure, called GADI (Group to support the Development of Inventions), attached to the central Law Office. At the university, the mission, size and status of GADI are currently being discussed, in order for USP to better cope with the new challenges and the potential benefits of co-operation with industry.

The University of the West Indies has, until now, been suffering from a weak national legislative framework in the area of intellectual property right protection. Within this context, it has been obliged to adopt quite a liberal stance itself towards intellectual property issues, whereby most IPR rest with the university staff.

Box 2. Intellectual property issues at the University of the West Indies

The traditional and legal frameworks of intellectual property in the region are quite weak. It is only recently, for instance, that copyright laws were passed in Trinidad and Tobago and they are frequently and flagrantly abused. There are few effective measures instituted by the state or other public and private organizations to protect creative and inventive work. The policy of The University of the West Indies on intellectual property must be seen in the context of its environment.

The university has traditionally maintained a rather liberal position on intellectual property and staff members who are authors of scholarly and artistic works, whereby copyright in textbooks, monographs, papers, lecture notes, unpublished manuscripts, slides, musical compositions, works of art, and similar material, are the exclusive property of the staff member, except where they are produced as part of a sponsored programme or other agreement or where the university claims ownership under this policy. On the other hand, inventions made by staff members within, or partially within, the staff member's normal field of activities or employment responsibilities, or making significant use of space etc., shall be the property of the university.

The university will allow a staff member who creates work in which the university claims property rights to share in any royalties that accrue from the sale or lease of the work outside the university.

The university does not claim any rights to work by students except where staff involvement in the actual creation of the work is substantial.

At Bogaziçi University, the issue of confidentiality and the protection of intellectual rights in collaborative research with industry has been on the agenda for a long time. However, no standard policies and procedures are yet in existence. It is left to the individuals concerned to work out suitable arrangements on a case-by-case basis. Since only very few projects with the productive sector are deeply research based, it is generally not very likely that a patent will be generated.

The Papua New Guinea University of Technology reports a similar state of reflection on appropriate rules. However, the author is somewhat more optimistic about the potential for future patent filing.

Box 3. Technology transfer and commercialization of intellectual property at the PNGUT, Papua New Guinea

The issues of technology transfer and ownership of intellectual property are still under consideration by the university. In this connection, the Executive Manager recently wrote the following:

The full investment potential of UDC as the commercial arm of the university, particularly in the commercialization of intellectual property rights, has not been realized both materially and financially. The potential is good, in fact the advantages are all in the university's favour as the premier technology institution in the country. By striving to gain and maintain intellectual excellence and capabilities, the university through UDC must, of necessity, hold exclusive rights over new technologies developed within its departments. The protection of intellectual property and sale of related new technologies under exclusive rights are areas where the potential exists for substantial investment in future; and the key is downright intellectual excellence. The promotional and enhancing role of UDC must accompany research and development in this respect.

> Research and development of new technologies are areas which call on the intellectual capacity of the university in its entirety as an institution of excellence in learning and research for academics and students alike. Although R&D in itself is neither a commercially viable nor profitable activity, there are prospects. UDC would act on behalf of the university for academics wishing to commercialize their inventions. By accepting the invention UDC would assign certain rights to the inventor and consequently invest in patenting and marketing. So much though for the absence of copyright laws in PNG.
>
> It would appear that some very interesting new technologies have been and continue to be invented right here, but these are somehow transferred quietly abroad for security under copyright laws and from which point, the return upon commercialization would be highly attractive. A quick look around reveals that there is one prototype coconut dehusker being tested, an electric train concept is being developed, and countless other food derivatives have been successfully developed from local fruits, vegetables and tree crops. Commercialization through downstream processing and marketing of such products may be well beyond UDC's current level of proficiency, but with the ownership of intellectual property rights and the ability to maintain R&D for specific products, to follow up with refinements and/or developments, there is scope for improvement.

The above-mentioned accounts on the issue of the management of intellectual property rights demonstrate that higher education institutions have clearly understood the importance of the issue of IPR for both their staff and the whole institution, and the necessity to develop policies, structures and procedures in this area. However, the reality of most institutions, in particular in the developing countries, is that such policies are often lacking and that structures and procedures would need to be put in place. What is at stake is not only the financial benefit, but also the recognition of work performed by research staff in higher education institutions and the contribution made by the public through the budget provision granted to the institution. At present, higher education institutions often lose out in the bargaining process with private enterprises over IPR, since private companies give much importance to being granted exclusive IPR within a joint research project on an invention. They tend to forward the argument that the university contribution to an invention is most often pre-competitive and that new knowledge generated through university R&D needs major investment to reach the stage where it will apply for patenting, and that higher education institutions are badly equipped to bridge the development gap that turns an invention into a patent.

It is, however, quite clear that the importance of the issue will grow when expected financial benefits will grow. When such expected benefits attain certain levels, it can be expected that institutions will set up specialized structures, develop internal expertise, or contract specialized external knowledge such as that found at Yissum at the Hebrew University, or the GADI at the University of São Paulo, to deal with the issue in the interest of the institution.

8. CONCLUSIONS

The 12 case studies on the management of relations with industry have confirmed that relations with industry have developed considerably over the past decade in all analysed universities. There are ***three*** main reasons for this development. ***First***, the growth in relations between universities and industries is due to external requests, mostly made by governmental authorities, for increased relevance and impact on economic development. ***Second***, the same governments have established a wide range of incentive measures at the national level, such as matching grants and tax alleviation. And ***last but not least***, institutions have been more and more pressed to supplement diminishing or stagnating core resources with funding from the private sector. It is certainly true to say that these three driving forces have jointly created an important momentum and an attitudinal change within institutions which are reflected in the development of new policies, structures and instruments in support of university-industry relations.

If such relations have developed in number, it is also fair to say that their scope has widened to embrace new types of linkages and modalities for their implementation. As a consequence, traditional types of linkages tend to co-exist with more recent ones. With regard to a traditional type of linkage, placement schemes for student internships are still a predominant mechanism. Innovative ways of organizing such student placements such as through the practice school scheme at the Birla Institute of Technology and Science and the Co-operative Education Programme at Suranaree University of Technology, have been presented in the case studies. Such innovative schemes demonstrate that it is possible to integrate practical periods in the overall training provision in such a way that they become a meaningful and highly complementary part of the overall training provision. Also, internships are not necessarily linked to technological studies only, but they can be a natural component of any training programme.

More recent types of linkages have been developing in the field of continuous professional development and consultancies. Within a context of resource constraints, universities tend to marketize those products where they have a comparative advantage over other providers.

A further, most recent and increasingly important type of linkage is enterprise development. Many higher education institutions and nearly all case institutions have developed special structures such as incubators or innovation centres, or specific programmes of enterprise development, such as the Uganda Gatsby Trust, at the Faculty of Technology of Makerere University. Enterprise development can be geared either to the development of existing SME's or to the creation of start-up firms, usually set up by an academic staff member or a graduate student to commercialize a university invention. Start-up firms are usually logistically supported by so-called business incubators or innovation centres, which may be an interface structure managed by the university or in which the university plays an important role. A more active part in the domain of enterprise development makes the university an increasingly important partner in local economic development. In general, one might conclude that there is a tendency for linkages to be drawn up and developed as strategic alliances rather than simple collaborative work conducted in the short term.

The account of developing and diversifying types of linkages with industry, driven often by the financial imperative, throws up the discussion of whether, and to what extent, such activities are part of the mission of the university. The issue is finally whether universities have a comparative advantage over other organizations and institutions in this domain and to what extent should universities be involved in activities traditionally conducted by private enterprises. This is of course a question which refers to basic ideologies and personal belief systems. Institutional and national decision-makers respond to such questions and define policy accordingly with reference to national traditions and value systems. However, as a general rule, one may argue that universities, whenever they have the choice, should give priority to linkages which strengthen, not weaken, their traditional mission of knowledge generation and transmission, basic and applied. Accordingly, first preference should be given to collaborative activities which have the potential of generating knowledge and enrich the professional experience of students and staff. A second preference should be given to linkages which are able to supplement diminishing governmental core funding in such a way as to strengthen the core activities of higher education institutions, which are teaching and research.

Our case examples have demonstrated that as the relations of higher education institutions with enterprises are developing, they become more complex and also more difficult to manage. Management of these relations refers to both strategic and operational management issues. Strategic management of university-industry relations means that the development of university-industry relations is established as an explicit university-wide, medium and long term objective and part of the overall university mission. It is also important that such objectives are expressed in operational and quantifiable terms to enable evaluation later on. Since the development of such relations has traditionally been a matter for individuals and departments, it is only more recently that the central administration has tried to co-ordinate, guide and support initiatives which are naturally of a bottom up nature. This case study research has shown that, however dynamic institutions are, only few of them have a written statement of policy for the development of their relations with industry. Strategic management of university-industry relations is necessary, however, to avoid that universities may be seeking immediate profit and compromising their longer term vision, in particular in a context of financial stringency from the public budget.

Strategic management of university-industry relations is also concerned with the development of appropriate structures through which such a strategy of university-industry linkages can be implemented. The case study research has shown that all institutions have set up numerous such structures, be they internal or external interfaces, many of which are interwoven and interrelated in some way. As a consequence, strategic management of university-industry relations needs to be concerned also with the co-ordination of such structures through a central authority which reports to the highest executive level in the university, the head of institution or governing body. Without central management, newly established structures or activities are in danger of being sidelined by a longer-established department of the university. Also, strategic management can ensure that there is a synergy and natural affinity of purpose between traditional and newly established units of the university.

Strategic management of university-industry linkages implies that such strategies are backed up by top management in order to receive recognition from the academic community members, who are the most important actors in it. As a consequence, the generation of strong faculty involvement and commitment is the basis of any development programme in this domain. University-industry linkages, in particular at a traditional university, often play a secondary role at the university whose traditional tasks are teaching students and doing basic research. Academic staff will only support a university-industry programme if they perceive its usefulness for the institution and their own work, for instance in terms of generating income and widening research opportunities. Often, cultural change is necessary to modify existing perceptions of the need to collaborate with industry. A change in the rules pertaining to academic advancement which traditionally do not give any credit to collaboration with industry may have a very strong signal effect in this respect.

Another element of strategic management refers to the decision-making structure in general and the composition of governing bodies, in particular for policy-making in the domain of university-industry linkages. Since it is of crucial importance that the thrust of the programme and services offered to the productive sector matches its needs, it is essential to link a limited number of leading local business people through their membership in a central governing board. Likewise, the board must include senior academics and administrators from the university to ensure that activities and policies are consistent with the academic strengths and aspirations of the university and that they will have the support of its academic community.

All case studies have demonstrated that the creation of interfaces, be they internal or external, is a common feature of developing university-industry relations. The above discussion of the case studies demonstrates a number of trends of which the first one is ***an increasing diversification and specialization of interfaces.*** This is not very surprising, given the fact that the objectives of these relations have become more diverse. If the initial objective has been the fostering of knowledge transfer from higher education institutions to industry, the income generation purpose now stands much more in the forefront and drives relations with industry forward in more diverse forms. The case studies have also shown that relations with industry are in fact a dynamic process reflected in the diversification of organisational structures, at the institutional level. If institutions often start with the setting up of an industrial liaison office, they then, over time, put into place external interfaces such as foundations or consultancy centres. The manifold tasks implied in managing university-industry relations, require a professional management with many specialized competencies. Managing continuous professional development is not the same as providing support to research teams for the negotiation of contract terms.

Specializaton of interface functions is taking place in a context where such interfaces are granted ***increasing autonomy*** in order to bypass internal rigidities such as administrative rules and the existing organizational structures along departmental lines. Administratively autonomous interfaces can then contract personnel with the particular skills needed, in particular in the technology management area, purchase necessary equipment and materials, organize interdisciplinary teams, negotiate contractual arrangements, etc. The particular challenge, however, for the mother institution is the control of these structures with the aim of making sure that they all contribute to the overall institutional mission and policy. Most institutions have developed effective, both formal and informal mechanisms. Formal mechanisms are rules and regulations that stipulate the level of autonomy of the interfaces whereas informal mechanisms try to place high level university managers in their governing boards, sometimes also at the top executive level of the interface. Such executives should however be above all professional managers preferably with some experience in academia, in order to be able to direct the interface in a professional manner.

The interfaces discussed in the case studies distinguish themselves very much by the level of their centralization. The issue of centralization is linked with the question of control and how communication is assured with the basic units of the alma mater. Only four of the case institutions have university-wide interfaces, i.e. Yissum of the Hebrew University, BUVAK of Bogaziçi University, UDC of the Papua New Guinea University of Technology and the Technology Innovation Centre of Birla Institute of Technology and Science. All other interfaces are set up by faculties or even departments, such as the foundations at the University of Sao Paulo, the Institute of Continuing Education of the Faculty of Engineering of the University of the West Indies and TECO of the Faculty of Technology of Makerere University.

With regard to their internal structuring, several of the interfaces indeed reproduce the departmental structure of their mother institutions or faculty. This demonstrates that interfaces are set up in such a way that basic units (i.e. departments) can have direct control over their subsidiaries. Such an organizational structure ensures a direct communication between the basic unit and its subsidiary and strengthens the ownership of departments over it.

Beyond the issues of strategic management and organizational development in the university-industry relations, this case study research has also been exploring innovative methods in the operational management of such relations. With regard to financial management, it could be demonstrated that the income generation impact may be considerable. At the University of Bogaziçi, income generation activities of diverse nature represent about 14 per cent of the total university budget and exceed the contribution from tuition fees. As a consequence, Bogaziçi is one of the institutions that have succeeded in establishing a diversified income basket and to create real margins of autonomy.

Within this context, higher education institutions are currently designing appropriate instruments for the costing and pricing of products, rules for the determination of appropriate overhead provisions and the distribution of generated income. They are also developing instruments such as risk capital to finance high-risk joint ventures with enterprises. With regard to costing and pricing, case universities mention that their price setting is usually guided by a full cost approach, and not by a price that the market will bear. Institutions generally charge a flat overhead rate for the use of equipment and central services. However, they are struggling with identifying the precise full cost of a product or service, especially in the R&D domain, given the fact that traditional accounting systems do not make a distinction between services related to teaching and research. Some institutions, however, make a distinction in overhead rates depending on whether work is laboratory based or not, the former entailing a higher overhead rate. Many institutions show a surprising flexibility in their overhead rate which seems to be negotiable. It is important, however, to bear in mind that overheads represent a part of the full cost of a product or service. As a consequence, institutions should avoid to make offers beyond real cost, unless they do this consciously.

With regard to the issue of distribution of income generated from collaboration with the productive sector, the case studies have brought to light that institutions are adopting very different practices which reflect various underlying conceptions of the place of the work with industry. Those who consider that such activities are part of the mainstream mission, foresee a rather small percentage of the generated income for the individual who has performed the job. Most institutions, however, assume that work with industry is not part of the mainstream activities and that individuals need to receive a specific remuneration for such work. They give preference to a distribution of generated income that acts as a financial incentive to individuals or teams of researchers. Again, some institutions make a difference in their rules for the distribution of income with regard to whether work is laboratory based or not. In the case of joint laboratory based R&D, a greater share of generated income, goes to the institution or to the department, in the case of a devolved budgeting system.

Finally, the rules pertaining to the distribution of generated income have the potential to counteract one of the inherent dangers in the development of linkages with the productive sector, this increasing fragmentation of the university, as well as conflicts among and within departments. In the domain of university-industry linkages, some departments have a higher potential for collaboration than others. As a consequence, these departments are able to generate important resources and have access to a great number of material incentives, whereas others have not. It is a difficult duty for institutional managers to counteract these natural trends of fragmentation and establish rules which allow all entities of a university to benefit from the resources generated from collaborative activities with industry. This can be done most easily through retaining a certain percentage of income generated at the institutional level which can then be redistributed to other entities. Such rules are however often exposed to internal conflicts, given the highly political nature of internal resource allocation in a university.

The distribution of generated income is an issue that is tightly related with the discussion of personnel policy. In the case study research, the questions were posed of staffing and staff development, incentives, the protection of the right to publish and finally codes and ethics for the collaboration with the private sector. The question of staffing and staff development is of course of crucial importance, since the strengthening of relations with industry depends in the first place on the competencies and skills of the staff involved and the building of understanding and awareness among all personnel, both academic and support staff. Very few universities have conducted audits to determine the precise competencies needed and to offer appropriate training schemes. With a view to developing relations with industry, staff recruitment and development are hardly ever based on a needs analysis, but they are generally done in an ad hoc manner, if at all. The Practice School scheme at BITS is an interesting innovation, which places teaching staff regularly in enterprises to both collaborate in projects and supervise students in situ during their internships. The Centre for Technological Innovation of UNAM in Mexico offers regular in-house training to university staff on specific topics related to technology transfer. The University of Sao Paulo has a similar training provision. These institutions are however quite big institutions with a well developed R&D capacity. The more common strategy is to recruit new staff, for instance for the liaison office, with the appropriate competencies, such as working experience in industry and a good knowledge of R&D work in the university. More specialized competencies and knowledge such as those related to the management of intellectual property, are often sub-contracted by HEI's. This is however not without problems, since outside specialists often do not understand the nature of university-based R&D work, this leading to internal conflict and delay in the negotiation of the terms of reference of contract work.

However, appropriate staffing and staff development are not enough to motivate university personnel to engage in university-industry relations. Financial or material incentives are necessary to signal to staff that the institution values their involvement with the private sector. All case institutions have put into place a series of incentives, some of which recognize collaborative work for decisions over promotions. If personnel statutes make the change of promotion criteria difficult, institutions try to provide material incentives, such as refurbished office space, or access to travel grants, to motivate staff. In one case institution, the Hebrew University of Jerusalem, a direct supplement to the basic salary has been determined to remunerate staff for their efforts in collaborative projects.

It is, without doubt, essential to encourage staff to collaborate and to develop new paths for collaboration with the productive sector, preferably, but not exclusively, through established procedures such as new promotion criteria, salary supplements and other material incentives. However, it is also important to make sure that traditional activities, in particular teaching obligations, are not neglected. Some universities do not allow their staff to commit themselves to any outside activities, if they are not managed by the university. This is however somewhat regrettable, given the fact that, for instance, consultancies linked to the speciality of the university staff are an occasion for professional enrichment, which is important to update teaching Most universities accept that a staff member spends one day a week with outside activities, but they expect the staff to inform their supervisors of such activities. Other universities have not established any rules and they implicitly expect university staff to adopt their own code of ethics. In contexts where university staff have difficulties in making a living with their salary, such a personal code of ethics might not be sufficient, since the natural trend will be to seek for outside employment. It then becomes a matter of survival for an institution to offer in-house opportunities for supplementing salaries as well as to establish university-wide rules and guidelines for the use of staff time for outside consultancies. And last, but not least, it is important to make outside work channelled through university structures more attractive financially and materially. As a consequence, support structures need to be supportive and not add supplementary workload such as paper-work, for instance.

Finally, a personnel policy geared towards the development of relations with industry, needs to preserve a university staff member's right to publish within given limits of time. This issue embodies the inherent conflict of industry, being concerned with the best protection of intellectual property and a university staff member's desire to publish in order to establish and maintain a professional reputation in a given speciality.

Those universities that have developed policies in the domain of intellectual property protection, have also usually addressed this issue. They have established rules regarding the maximum lapse of time during which publications may be withheld, generally for some months at a maximum. In order to protect university staff and the university as an institution, it is important that such rules are negotiable only at the margin.

A last issue addressed in the case study research is the management of intellectual property. Most universities acknowledge the potential importance of this issue, and they indicate that it is high on the political agenda. However, very few institutions world wide, among which the case institutions, have become active in this domain. This is at least partially due to the fact that there is not very much collaborative R&D between the university and the productive sector. Another reason is the weak legislative framework and the lack of tradition for the protection of patentable R&D. And finally, it is often difficult for universities to bring inventions up to a stage where they could be filed for a patent, given the fact that this often needs considerable supplementary investment and expertise. It is only when universities can expect an important benefit from the commercialization of IPR through royalties and licences that they set up appropriate policies, structures and procedures in this domain. The Hebrew University of Jerusalem is particularly active in this domain. Through its subsidiary YISSUM, considerable income is generated from IPR. YISSUM has reserved itself exclusive rights in this domain and centrally manages all issues; including the negotiation with industrial partners of the terms of IPR, setting up of joint ventures for the financing of further development to bring inventions to a patentable stage, the filing of patents and their commercialization. However, most other case institutions involved in collaborative R&D either leave IPR with the individual staff who were responsible for the R&D project, share IPR with the collaborating industry, or leave it entirely to the industrial partner. This is somewhat regrettable, since universities are not able to capitalize on their inventions institutionally.

The above-mentioned discussion of management concerns has brought to light that university-industry linkages have great potential to improve the quality of higher education services, both teaching and research. If they are managed with vision and wisdom at the institutional level, they can bring great benefit to the institution in terms of improved relevance and financial room for manœuvre. Also, they are a phenomenon of daily life at the institution, since those academics with marketable competencies usually do outside work with the productive sector anyhow, usually without informing their institution. What this research work is calling for is that institutions adopt clear positions and policies vis-à-vis such 'clandestine' collaborative activities and try to make them beneficial for the institution, both financially and from a substantive point of view.

A conscious management approach to the development of university-industry relations has also the potential to counteract a number of inherent problems in university-industry linkages. The one discussed already above is the growing fragmentation of institutions and the creation of internal conflict, given the differential potential of departments to engage in university-industry relations. Another one relates to the restrictions in publication schedules which might be imposed by industry for the sake of secrecy of R&D results. A third concern is that the R&D agenda of higher education institutions might become too much driven by the immediate developmental concerns of industry to the detriment of more strategic and pre-competitive research projects chosen by higher education departments. Again, the important point here is that institutions take a clear stance, define their policies and try to look at university-industry linkages as opportunities, but also as threats. This might entail a certain selectivity with regard to collaborative activities that institutions are willing to conduct jointly with industry.

The overall conclusion of this study on the management of university-industry relations is that higher education institutions need to develop a long-term vision of their relations with industry and the benefits that they expect from. That means that they have to go beyond the concept of 'relations' and 'collaboration' to the notion of 'co-operation'. The latter has to do with mental and attitudinal change, the sharing of values and mutual learning between organizations of different cultures and objectives, universities and industry. Such a process of attitudinal change requires a forward-looking and proactive management, both at the strategic and operational level and the putting in place of appropriate support structures, as has been demonstrated by the 12 international case studies analyzed above in their management endeavour.

APPENDIX 1

Guidelines for the case studies on the management of university industry relations

The following guidelines represent a list of possible items that could be addressed in the case studies on the management of university-industry relations.

Please note that these guidelines are only intended to provide authors with guidance regarding the topics and issues that could be covered in the case study. The proposed structure will also serve to allow for some comparability of cases.

Since each institution has its own specific history, structure and procedures, certain items are more relevant to some institutions than to others. Often programmes with industry are run in a decentralized way. Consequently, these guidelines should be adapted by authors to their own particular circumstances and they may refer only to parts of their activities conducted with industry, for instance at the departmental level.

1. Contextual factors

Please describe briefly the general features of national/regional and local enterprises (predominantly public/private enterprises, main sectors and their relative weight, relative growth of sectoral industries, size of the enterprises, etc).

Are there any national/regional programmes and funds available for facilitating the development of relations between universities and industry in your country?

2. Characteristics of your institution

Please describe briefly your institution with regard to its particular mission, its academic programmes and research priorities, student and staff numbers and its overall budget.

3. Past and current status of university-industry relations at your institution

Please describe the development of university-industry relations at your institution prior to 1992.

- What were the main linkage mechanisms and programmes prior to 1992 (student placements, staff exchange, sandwich programmes, joint curriculum development, continuing education, joint R&D, etc)?
- What major developmental stages could be distinguished in the development of university-industry relations of your institution?
- What were the main internal and external driving forces behind developments?
- Please describe the status of university-industry relations at your institution during the past five years.
- What types of linkages and programmes exist (student placements, staff exchange, sandwich programmes, joint curriculum development, continuing education, joint R&D, etc)?
- Please describe the objective, main partners, modes of operation of some programmes.

4. The management of university-industry relations at your institution

Strategic management of university-industry relations

- Has your institution developed an institutional policy geared towards the development of university-industry relations, such as its inclusion in the mission statement or a development plan? Please attach relevant documents, if available.
- Is there a particular focus for university-industry relations (such as regional development, collaboration with small and medium size enterprises, etc) or have relations grown from the grass-root initiatives?

Organisational development

- Has your institution set up *internal interface structures*, such as industrial liaison offices, focal points, public relations or marketing offices or offices for continuing education? Do they exist at central or decentralized (for instance at departmental) level?
- If so, describe their detailed role in the development of university-industry relations, their place in the organisational chart, their staffing structures and their modes of operation (in particular their interaction with other internal units and the academic staff)?
- Has your institution set up *external interface structures*, such as foundations, trading centres, research centres, incubators, science parks, etc?
- If so, describe their detailed role, their management structure, their staffing, their modes of operation and their budget (in particular their interaction with other internal units and the academic staff)?
- How are such external interfaces controlled by your institution?
- Is your institution involved in *networking arrangements* such as research consortia, or industrial affiliates programmes? Please describe.

- How do internal and external interface structures ensure communication with faculties, departments and research units?

Financial management of university-industry relations

- Has your institution been able to generate extra-budgetary funds through interaction with industry over the past five years or so? If possible, please attach a statement of expenditures and income.
- Has such funding contributed to the overall development of your institution ? If yes, in what way?
- Are there any rules for the distribution of funds generated through such activities (i.e. between the institution, the involved academic unit and the team/individual in charge of implementing the programme)?
- Are there special financial management procedures put in place for the relations with industry?
    - Does your institution provide a general budget/seed money or risk capital for joint ventures with enterprises?
    - If so, what degree of flexibility exists in the use of these budget provisions?
    - What degree of flexibility exists in the use of extra-budgetary funding generated by relations with industry?
- Does your institution have any guidelines or formulae for the costing of contracts with industry (overhead costs, staff time, management of projects)? If yes, please present or attach these guidelines or calculation methods.

Staff management

- Has your institution put in place incentive measures to motivate your staff to get involved in university-industry relations (i.e. criteria for career advancement, financial incentives, internal recognition)?

- Has your institution set up special statutory or contractual arrangements for employing staff engaged in projects conducted with industry (part-time, contractual staff, etc)?
- Does your institution provide for the development of competences needed by staff engaged in the management of relations or in collaboration with industry?

Management of contracts and intellectual property

- Does your institution provide support for the negotiation and drafting of research and training contracts ? Have you developed a model for such contracts? If yes, please attach an example.
- Are such contracts managed (financial management, monitoring, quality control) at the centralized (institutional) or decentralized (departmental) level? What is the intra-institutional distribution of responsibilities and what procedures exist?
- Does your institution have a policy regarding the publication of research results derived from joint R&D? Please describe.
- Does your institution have any policy regarding intellectual property (unilateral or shared ownership)?
- Are there any organizational structures or procedures in place regarding the management of intellectual property? If yes, describe them.

5. Evaluation of the benefits and drawbacks regarding the relations with industry

- Has there ever been an internal/external evaluation of your joint programmes with industry? If yes, please present the findings.
- What do you consider to be the main benefits derived from the collaboration with industry, i.e. financial, substantial, access to applied knowledge and up-to-date equipment, up-dated curricula, etc?

- What do you consider to be the main drawbacks?
- What problems have you faced in the development of your relations with industry?
- Have these problems been overcome, and if yes, how?
- What general lessons have you learnt for the management of relations with industry and what guidance could you give to managers of an institution that want to develop their relations with industry?
- What do you consider to be crucial success factors in the development of relations with industry?

6. Future prospects for the development of relations with industry

- What are the future prospects for the development of relations with industry?

APPENDIX 2

UNITECH DEVELOPMENT
& CONSULTANCY Pty. Ltd.

PROJECT NUMBER

☐

(Assigned by UDC)

CONSULTANCY APPLICATION

PROJECT INFORMATION

Name of Client	
Address	
Contact	Telephone
Title of Project	
Description of Project	
Principal Consultant	Department

CONSULTANCY FEES

Description	Projected	Actual
TOTAL CONSULTANCY FEES → B	K	K

RECOVERY OF PROJECT EXPENSES

Description	Projected	Actual
Subtotal Expenses >C		
UDC Handling Fee* (10% of C) >D		
TOTAL EXPENSES (C + D) → E	K	K

TOTAL PROJECT VALUE

Fees + Expenses (B + E) >F		
Provincial Tex (3% of (B+D)) >G		
TOTAL PROJECT VALUE (F + G) H →	K	K

* Projects with Total Expenses over K5,000 – Handling Fee is reduced to 5%

PROJECT DISTRIBUTION

RETURN TO DEPARTMENT

Description	Projected	Actual
Standard 10% of (B)		
Other Extraordinary Items		
RETURN TO DEPARTMENT → J	K	K

RETURN TO UNIVERSITY/UDC

Description	Projected	Actual
Standard 25% of (B)		
Handling Fees (From D)		
Other Extraordinary Items		
RETURN TO UNIVERSITY/UDC → K	K	K

RETURN TO CONSULTANTS

Participating Staff	Projected	Actual
TOTAL (65% of B) → L	K	K

APPROVALS

Principal consultant	Head of Department
Date	Date
UDC	Vice Chancellor
Date	Date
RECEIPTS ACCT #	PAYMENTS ACCT #

Rev 3, Apr 1994

UNITECH DEVELOPMENT & CONSULTANCY Pty. Ltd.

COURSE NUMBER

☐

(Assigned by UDC)

SHORT COURSE APPLICATION

COURSE INFORMATION **(PART A)**

Course Title		
Course Content		
Date (s) Course Offered		
Principal Instructor Other Instructors	% Share	Department

COURSE FEES **(PART B)**

Basic Course Fee	K
Special Course Fees (Optional)	K
Accommodation Charges (Optional)	K
Meal Charges (Optional)	K

ATTENDANCE **(PART C)**

Projected	Actual

INCOME STATEMENT **(PART D)**

Income	Projected	Actual
Basic Course Fees Special Course Fees Charges for Accommodation		
TOTAL INCOME → D	K	K

EXPENSE STATEMENT **(PART E)**

Expenses		Projected	Actual
Accommodation	- Student Services		
	- Guest House		
	- Lae Hotels		
	- Other		
Tea and Coffee			
Lunch/Dinner			
Photocopying			
Course Materials			
Course Administrative Assistants			
Break-up Function			
Advertising			
Instructors Fees (Non-Unitech)			
Transport			
Typing Costs			
Refunds			
Other Expenses			
TOTAL EXPENSES → E		K	K

NET PROFIT FROM COURSE **(PART F)**

Income Less Expenses (D-E) → F	K	K

APPLICATION OF PROFITS **(PART G)**

% Share of F		Projected	Actual
Return to Instructors (Apportioned as in Part A)	65%		
Return to Department	10%		
Return to University/UDC	25%		

Projected: To be completed when applying for course approvals.
Actual: To be completed after course has been conducted.

APPROVALS

Principal Instructor
Date

Head of Department
Date

UDC
Date

Vice Chancellor
Date

RECEIPTS ACCT #	PAYMENTS ACCT #

Rev 2, Dec 1992

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The book

Within the context of increased financial stringency and in response to the demand for relevant training and research programmes, higher education institutions are more and more inclined to strengthen their relations with the productive sector. Professional management of such linkages is crucial to the success of developing sustainable and mutually beneficial relations.

This book is the synthesis of a research project which explored innovative management practices in the domain of university-industry linkages. Managers from 12 higher education institutions in Europe, Africa, Asia, and Latin America were invited to document their experience on the management of interfaces, financial and personnel management, and the management of intellectual property.

The case studies demonstrate that while relations with enterprises increase, institutions tend to adopt more pro-active and better co-ordinated management approaches. They are also devising necessary rules and procedures to protect the traditional activities of higher education institutions from undue outside interference in order to make the most of university-industry linkages.

The author

Michaela Martin is a Programme Specialist at the International Institute for Educational Planning. An expert in policy-making, planning and management of higher education at the system and institution level, Ms Martin is in charge of a research project on the management of university-industry relations.

Managing university-industry relations:
A study of institutional practices from 12 different countries

international institute for
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